

The Blast Furnace Steel Plant

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The Battleground

THE industry familiarly and affectionately known as Steel is a battleground upon which titanic forces wage ceaseless contest for supremacy, a battleground with ever changing lines of fortification external and internal, a battleground upon which the ultimate genius for mobilization finds unlimited frontiers for self-expression.

No wonder Steel is a true barometer of national well-being!

The magnitudes involved run into the millions and billions. The influences penetrate into every walk in life from the fisherman in Alaska, who must conserve his catch in cans, to the banker in Wall Street, who distributes the investment issues which visualize the units of the industry.

More than \$4,000,000,000 measures the annual values directly produced by 500,000 employes to whom wages of \$1,000,000,000 are paid. By their combined labor these men add over a billion dollars of value to our economic fabric. And this has no relation to the vast dividends distributed upon invested capital.

Great as these values seem, they represent but a fraction of the real values which are made possible only by the constant battle for ultimates which is the daily life of Steel.

The history of Steel knows no armistice. Each year records its ebbs and flows; fashions change, methods improve, wastes become product, competition shifts from this country to that market, but the clang of conflict is never silenced.

The roars of the blast furnace wind, the detonations in the open hearth pits, the deafening explosions at the plate mills when salt meets water, the deathly gases at the blast furnaces, the pitiless heats of the Bessemer, the deafening whistles and the sharp toned bells which signalize a crane's approach with swinging load—these are among the warlike notes which every soldier in this titanic army comes to love and loves to hear.

It is upon such a battleground that these legions hope to marshal every force during a coming busy twelve-month.

Iron Ores of the World

A Broad Survey of the Important Ore Resources upon Which the Industry Must Draw

By OLIN R. KUHN†

IRON comprises 4.44 per cent of the earth's crust and its oxide form "ore" is one of the most abundant materials found. It is by far the most useful substance and more than 95 per cent of the world's metal output is iron.

Iron is found in its oxide in the form of ore which varies greatly in composition from magnetite, the richest ore, to siderite and pyrite, the poorest. These ores occur generally in various forms in the igneous and sedimentary rocks. The following table and chart show the composition of the principal typical iron minerals.

The following short description gives an idea of the various grades of iron ore found in the different countries throughout the world. In the analyses following the description of the deposits I have endeavored to pick out ores that would be representative of the various mines or deposits.

United States.

The Lake Superior iron ore district in the United States of America is the largest iron producing district in the world. This region is divided into six main ranges, the largest being the Mesabi. The ore on the Mesabi Range is generally a soft hematite averaging 58.50 per cent of iron and the mining is done by open pit, milling, and underground methods. The largest open pit in the world is located on this range and has produced more than 12 million tons in one year. On the Cuyuna Range the ore is a soft hematite averaging 51.00 per cent in iron and 5.0 per cent in manganese. On this range also the mining is carried on by open pits and underground. The ore on the Menominee Range is also a soft hematite although there is some limonite found on this range. Most of the mining here is underground and the ore averages 55.00 per cent in iron and the phosphorous content of the ore on this range is higher than that found on the other ranges, usually from .350 to .400 per cent. The ore on the Gogebic Range is somewhat harder hematite carrying about 60.00 per cent of iron and practically all of the mining is underground. The Vermilion and Marquette Range ores are considerably harder than those found on the other

ranges. The iron content of the Vermilion Range ores averages 62.00 per cent of iron, but those of the Marquette Range, due to the large amount of siliceous ores, only averages about 56.00 per cent in iron. The production of the Lake Superior district is about 50 to 60 million tons annually of hematite ore averaging 58.00 per cent in iron and 8.50 per cent in silica.

The Adirondack district in eastern New York State is the largest producing district in the North-eastern States Region. The production here and in northern New Jersey is magnetite ore, mined underground, most of which is concentrated. The concentrated product carries from 62 to 66 per cent of iron. In eastern Pennsylvania there is the famous old Cornwall Ore Banks which is still operated by quarrying methods. The ore here is magnetite which carries 40 per cent of iron in the crude ore and 50 to 65 per cent in the concentrates. Clinton hematite and carbonate ores are found in New York, Pennsylvania, Ohio, and Indiana but they are not developed at present.

The Southern States Region includes the vast Birmingham and Chattanooga ore fields which contain Clinton hematite and brown ore. The Clinton ore only carries about 36 per cent of iron but it is very high in lime which makes it practically self fluxing. The brown ore averages about 50 per cent in iron content. Virginia and Tennessee also contain large bodies of Clinton and Brown ores but at present they are not extensively worked. There is a large deposit of hard hematite ore in Missouri which is being worked at present but only for local consumption. In eastern Texas there is a vast body of brown ore carrying about 46.50 per cent of iron but it is undeveloped.

The western part of the United States contains several scattered deposits of hematite and magnetite ores but aside from some mines in Wyoming and Utah there has been little development. Montana is said to contain a large deposit of high grade hematite ore averaging about 65.0 per cent of iron and there are several large deposits in California.

Newfoundland.

One of the largest deposits of high grade hematite ore known outcrops on Bell Island in Conception Bay,

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COMPOSITION OF PRINCIPAL IRON MINERALS

Name	Chemical Formula	Iron	Sulphur	Carbon Dioxide	Oxygen	Water
Magnetite	Fe ₃ O ₄	72.4	.....	.....	27.6	.....
Hematite	Fe ₂ O ₃	70.0	.....	.....	30.0	.....
*Thurgite	2Fe ₂ O ₃ , H ₂ O	66.2	.....	.....	28.5	5.3
*Goethite	Fe ₂ O ₃ , H ₂ O	62.9	.....	.....	27.0	10.1
*Limonite	2Fe ₂ O ₃ , 3H ₂ O	59.8	.....	.....	25.7	14.5
*Nanthosiderite	Fe ₂ O ₃ , 2H ₂ O	57.1	.....	.....	24.5	18.4
*Limonite	Fe ₂ O ₃ , 3H ₂ O	52.3	.....	.....	22.4	25.3
Siderite (Carbonate)	FeCO ₃	48.2	.....	37.9	13.9	.....
Pyrrhotite	FeS	60.5	39.5	.....	.....	.....
Pyrite	FeS ₂	46.7	53.3	.....	.....	.....

*Brown Ores.

Newfoundland, and extends out under the waters of the bay. The ore ranges from 48 to 57 per cent in iron and from 6 to 12 per cent in silica. Much of this ore has been shipped to Germany during the last few years.

Canada.

There are no very large producing iron mines in Canada although in the province of Ontario there are several operating properties. The ore is magnetite carrying from 36 to 60 per cent of iron. Other deposits of magnetite occur in New Brunswick, British Columbia, and Quebec but none of them are developed at present.

Mexico.

Several deposits of high grade hematite ore that can be mined by open pits are found along the west

quarrying and is owned by steel companies located in the United States where practically all of the ore is shipped.

Porto Rica.

There is a large deposit of limonite ore in Porto Rica very similar to the brown ores of Cuba, but as yet it has not been developed.

Argentina.

Several deposits of magnetite ore have been reported in Argentina but they have been little explored and there has been no development.

Brazil.

The Minas Geraes district in Brazil contains one of the largest deposits of high grade hard hematite ore known. This ore carries from 63 to 70 per cent

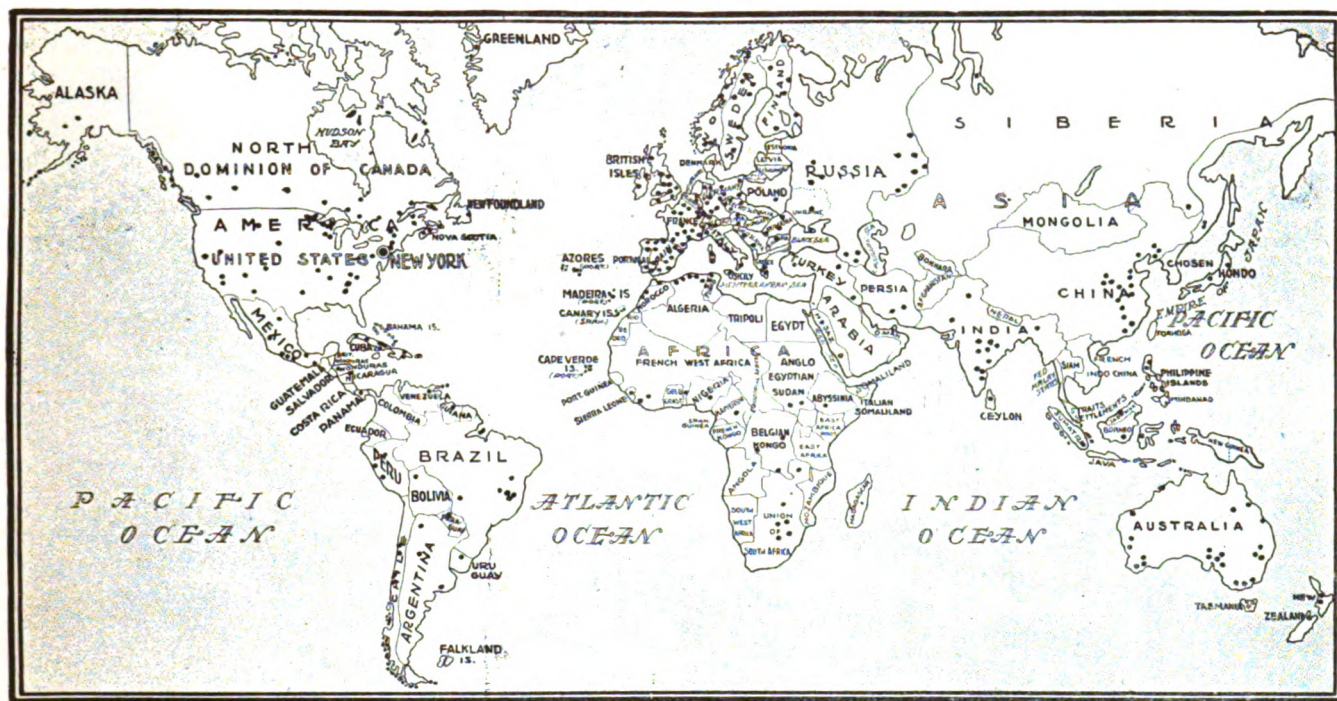


FIG. 1—Map of the World showing the locations of the Iron Ore Deposits.

coast of Mexico. The ore averages from 60 to 70 per cent in iron and from 3 to 7 per cent in silica. United States capital controls most of the Mexican ore.

Central America.

Deposits of magnetite ore carrying from 65 to 70 per cent of iron have been found in Honduras, Nicaragua, and Panama but to date there has been no development.

Cuba.

Cuba contains one of the large known iron ore reserves although the ore in the crude form is fairly low grade. There are five main districts of brown limonite ore in Cuba, three in Oriente province, one in Camaguey province, and one in Pinar del Rio. The ore averages about 46.0 per cent of iron and 44.25 per cent of water in the crude ore. This ore is dried and nodulized into a product carrying 55.0 per cent of iron. Near Santiago there is a deposit of magnetite and hematite ore which averages from 55 to 65 per cent in iron. All of the ore in Cuba is mined by

of iron and there are more than 30 known deposits in this district. This reserve is controlled by Americans, French, English, German, and Brazilian capital but there has been practically no development. Other deposits of hematite ore are found scattered through other districts in Brazil but little is known regarding them.

Chile.

Deposits of high grade hematite ore carrying from 55 to 70 per cent of iron occur along the coast of Chile north of Valparaiso. The Tofo Mine is probably the largest of these deposits. The ore from this quarry averages 67.50 per cent in iron and it is owned by the Bethlehem Steel Corporation in the United States where all of the ore is shipped.

Dutch Guiana.

There is a deposit of limonite ore reported in the Dondermarry Mountains in Dutch Guiana which carries from 43 to 60 per cent of iron but the deposit has not been developed.

Paraguay.

Several deposits of hematite ore occur in Paraguay carrying from 40 to 50 per cent of iron but little is known regarding them.

Peru.

The largest iron ore deposit in Peru occurs at Marcona in the province of Ica. The ore is hematite averaging from 60 to 65 per cent in iron. Other deposits of high grade hematite and magnetite ore are found at Huacavilca, Aija, and Callaycancha but there has been practically no development of the Peruvian deposits.

Uruguay.

There is a deposit of manganiferous ore at Zapucay in the province of Rivera in Uruguay which carries 35 per cent of iron and 23 per cent of manganese, but at present it has only been scantily explored.

Venezuela.

The main iron ore deposit in Venezuela occurs at Imataca and contains magnetite and hematite ore averaging 66.50 per cent in iron. Some of this ore was shipped to the United States in the past but there has been little production in recent years. There is a deposit of hematite ore at Piacoa which carries from 50 to 60 per cent of iron but this mine is not being operated at present.

Great Britain.

Deposits of iron ore are scattered all through Great Britain but the ore is generally low grade jurassic or carbonate ore. The largest deposits of jurassic ore are found in Northampton, Lincolnshire, Yorkshire, Oxford, and Warwick, while the main carboniferous deposits occur in Staffordshire, Derby, South Wales, and Scotland. The iron content in the jurassic ore averages from 22 to 36 per cent and in the carbonate from 27 to 36 per cent. Much of the jurassic ore is calcined before it is used. There are several small deposits of hematite ore in Cumberland and Lancashire which carry from 50 to 60 per cent of iron. About 30 per cent of the ores consumed in Great Britain are imported from Spain and Sweden.

Norway.

There are some large deposits of low grade magnetite ore at Sydvaranger and Dunderland in Norway. This ore only averages about 36 per cent in iron and is concentrated before it is shipped. There are several deposits of titaniferous ore, the largest of which is on Lofoten Island, but they have not been developed.

Sweden.

Sweden has long been noted for its deposits of high grade magnetite ores, about 85 per cent of which is exported to Germany, England, etc. Practically all of the large deposits are in northern Sweden and the ore usually averages well over 60 per cent in iron. The Kiirunavaara deposit is by far the largest and is a mountain of iron ore rising 800 feet above the level of the nearby lake. Most of the ore can be mined by quarrying.

Finland.

Several small deposits of magnetite ore occur in Finland, mainly at Jussaro and Pitkaranta but the ore is low grade, 26 to 38 per cent in iron, and they are practically undeveloped.

Russia.

There are large deposits of hematite ore in southern Russia at Krivoi Rog and on the Kertch peninsula. The ore at Krivoi Rog contains from 50 to 70 per cent of iron but that at Kertch is oolitic and only contains from 40 to 45 per cent of iron. In central Russia there is a large deposit of brown hematite ore at Lipetsk which contains 52 per cent of iron and another smaller deposit in Vladimir which averages 40 per cent. Deposits of hematite and magnetite ore are scattered through the Ural Mountains but there has been little development of these deposits. There is a small deposit of high grade ore, 62.0 per cent iron, at Daschkiesan in the Caucasus. Before the revolution Russia produced about 10 million tons of iron ore annually but since then the production has been less than one million tons per year.

Germany.

In the Treaty of Versailles Germany lost her largest iron ore fields, the Lorraine Basin, and now she must import a great part of her ore requirements. The largest deposits remaining in Germany are in the East Rhine, Weser, Bavaria, Wurttemberg, and Thuringia districts. The bulk of the ore in the East Rhine district is low grade siderite and hematite carrying from 20 to 40 per cent of iron. The siderite ore is usually roasted before it is used. In the Weser district the ores are hematite and brown ores averaging from 30 to 40 per cent in iron. There are several large deposits of fairly good brown ore in Bavaria and Wurttemberg which contain from 50 to 55 per cent of iron. In Thuringia there are several deposits of Chamosite, a hydrous iron aluminum silicate, which must be roasted before it is used.

Luxemburg.

One corner of the famous Lorraine Basin extends into Luxemburg. Most of the ore here is exported to Germany.

Belgium.

The Namur-Liege field is the largest in Belgium and contains oolitic hematite ore carrying from 25 to 45 per cent of iron. Brown ores containing from 30 to 35 per cent of iron occur in the Campine district. The production of iron ore in Belgium is small and most of her ore requirements are imported.

France.

The Lorraine Basin in northeastern France is one of the largest deposits of iron ore in the world. The ore is minette or oolitic limonite and carries from 25 to 48 per cent of iron. The high lime content in these ores makes them self fluxing so that they can be used without any beneficiation although they are low grade. In Normandy in northern France there are several large deposits of carbonate ore which have been altered to hematite near the outcrop. These ores contain from 43 to 48 per cent of iron and are quite high in phosphorus. There is a deposit of magnetite at Dielette which averages 51 per cent in iron. Brown and siderite ores averaging 46 per cent in iron occur in Brittany and Anjou, and several smaller deposits of hematite and siderite are scattered through southern France.

Spain.

Deposits of iron ore are scattered all through Spain and the production averages about five million tons

annually, a great part of which is exported. The ore is mostly found in the tops of the mountains and the mining is done by quarrying. Practically all grades of iron ore are found in Spain and much of it is below the Bessemer limits in phosphorous. As a rule, the iron content is fairly high and these ores are very desirable to mix with the lower grade European ores.

Portugal.

The Moncorvo deposit in Portugal contains hematite ore averaging 50 per cent in iron. Other deposits of hematite and magnetite ore occur at Porto de Moz, Sao Thiago de Cacem, and Serra dos Monges but there has been little development and the production is practically negligible.

Jugo-Slavia.

The Vares district in Bosnia is the only deposit of economic importance in Jugo-Slavia. Here the ore is hematite and limonite and averages from 40 to 60 per cent in iron.

Rumania.

In Rumania there is a deposit of hematite and magnetite ore carrying from 50 to 65 per cent of iron in Banat and deposits of spathic and brown ore occurs in the Hunyad district, but the production is small, only enough for local requirements.

Poland.

There are several large deposits of brown ore in



FIG. 2—View of a typical open pit mine in the Upper Lake Region.

Switzerland.

A large deposit of limonite ore has recently been discovered at Fricktal which is said to average from 25 to 35 per cent in iron.

Italy.

There are many small deposits of hematite, magnetite, and limonite ore in Italy which carry from 45 to 66 per cent of iron, but the reserve is not large and the production is only about enough for the domestic requirements.

Greece.

There are several deposits of hematite ore in Greece which contain from 45 to 52 per cent of iron, and as Greece has no iron industry practically its entire production, about 150,000 tons annually, is exported.

the Radom district in Poland which carry from 26 to 30 per cent of iron but there has been little exploration and no development.

Austria.

The Erzberg deposit of siderite in Styria, Austria, is a mountain of ore averaging about 38.73 per cent of iron in the crude ore. This ore is mined by bench quarrying and is calcined before it is used. A small deposit of siderite and limonite ore containing from 43 to 49 per cent of iron occurs at Huttenberg in Carinthia.

Czecho-Slovakia.

The largest deposits of iron ore in Czecho-Slovakia are in Bohemia in the Brada Mountains. The ore is a low grade oolitic hematite averaging about 35 per

cent in iron which is calcined into an ore carrying 44 per cent of iron. Deposits of siderite and brown ore containing from 34 to 50 per cent of iron are found in Ruthenia and small bodies of hematite and magnetite occur in Moravia.

Algeria.

Deposits of red and brown hematite ore occur in Algeria all along the coast of the Mediterranean Sea and the border of Tunisia. These ores carry from 46 to 59 per cent of iron and are low in sulphur, phosphorous, and silica. The production of Algeria is about 1½ million tons annually.

Tunisia.

The main deposit in Tunisia is in the Djerissa-Slata district and the ore is hematite containing from 48 to 55 per cent of iron and low in silica, sulphur, and phosphorous. There is also a large deposit of hematite ore averaging 52 per cent in iron in the Gafsa district and a smaller one in the Douaria district.

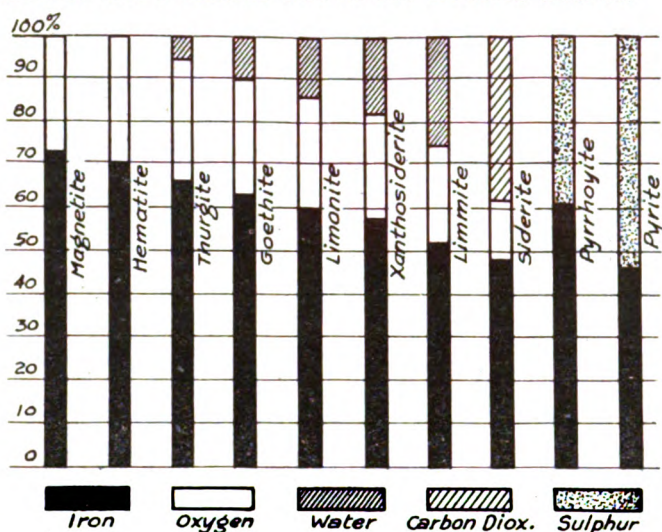


FIG. 3—Chart constructed to show the chemical proportions natural to various types of iron ores.

Morocco.

Several deposits of red and brown hematite ore occur in the Melilla district in Spanish Morocco. This ore is mined by open quarries and contains from 50 to 62 per cent of iron.

French West Africa.

In Togoland in French West Africa there is a deposit of hematite ore at Banyeli averaging 50 per cent in iron but it is not developed.

British West Africa.

There is a deposit of high grade limonite ore in Sierra Leone which carries 59.90 per cent of iron and one of laterite and limonite in Nigeria containing 46 to 56 per cent of iron but neither deposit is developed.

British East and Central Africa.

Deposits of hematite, magnetite, and brown iron ores containing from 55 to 70 per cent in iron are reported in Nyasaland but they are not developed and have been little explored.

Egypt and Sudan.

Deposits of hematite carrying from 48 to 55 per cent of iron occur in Egypt and the Sudan but they are not developed.

Madagascar.

Several deposits of magnetite ore carrying 65 per cent of iron are found on the island of Madagascar but as yet there has been no development.

Union of South Africa.

Large deposits of oolitic ore averaging 48 to 54 per cent in iron occur in Pretoria and Potchefstroom in the Transvaal and smaller deposits of hematite are found at Buffelsshoek, Kromdraai, and in the east Transvaal. There are also several small deposits of limonite and hematite ore reported in Natal but up to the present there has been practically no production of iron ore in the Union of South Africa.

Rhodesia.

An extremely large deposit of laterite ore averaging 25 per cent in iron is reported near Lake Bangweolo and some high grade hematite and magnetite ore has been found in Southern Rhodesia, but like in the Union of South Africa there has been practically no development.

Persia.

Small deposits of hematite ore have been reported from Persia but they are relatively unimportant.

India.

India is estimated by some to contain the largest reserve of iron ore in the world. The larger deposits are in Bengal, Bihar, and Orissa at Singhbhum, Manharpur, and Mayurbhanj. The ore here is all high grade hematite carrying from 64 to 69 per cent of iron that can be easily mined. Deposits of high grade hematite ore also occur in Burma, the Central Provinces, and Maysore. The production of iron ore in India has not been large in the past but it is increasing rapidly each year.

China.

The bulk of the iron ores of China are low grade hematites and magnetites although there is a little high grade ore found. About 80 per cent of the ores of China are in the province of Fengtien or Manchuria. The ores are usually low grade, 30 to 40 per cent in iron, and in many cases have to be concentrated before they are suitable for furnace use. Seventeen provinces of China contain evidence of iron ore but only six of them contain deposits of commercial importance. These provinces are Chihli, Fengtien, Shantung, Hupei, Anhui, and Fukien. Most of the mining is done by open pit methods and the production is from 1 to 1½ million tons annually. About 50 per cent of the iron ore industry of China is controlled by the Japanese.

Japan.

There is a fairly large deposit of magnetite ore, containing 60 per cent of iron, at Kamaishi and several deposits of hematite carrying 35 to 62 per cent of iron in the northern part of Japan. Deposits of brown ore occur in Abuta, Kotaki, and Honshu and hematite ore averaging 56 to 60 per cent in iron has been found in Korea, Japan produces only about half of her requirements and the balance is mostly imported from China.

Siberia.

Several large deposits of magnetite ore averaging from 54 to 58 per cent in iron have been reported in western Siberia and some magnetite and hematite ore

REPRESENTATIVE ANALYSES OF IRON ORES FROM VARIOUS COUNTRIES

Country and Section	District	Grade or Deposit	Type of Ore	Treatment	ANALYSIS							
					Iron	Silica	Sul.	Phos.	Mang.	Alum.	Lime	CO ₂
Algeria—												
Oran	Beni-Saf	Brika	Hematite	Crude	50.00	5.35	.040	.030	1.00	.75	6.55	6.50
	Sebabna	Sebabna	Hematite	Crude	49.10	7.10	.108	.070	6.25	1.00	3.00	9.20
Algiers	Chelif Valley	Rouina	Hematite	Crude	53.00	6.00	.080	.035	.60	...	3.00	...
		Zaccar	Hematite	Crude	45.00	5.00	.030	.019	1.30	...	6.50	...
	Djebel Hadid		Hematite	Crude	54.16	3.63	.013	.077	1.35	.29	4.29	11.51
Constantine	Bou Kadra		Hematite	Crude	58.17	3.19	.061	low	2.38	...	...	...
	Lal Lal		Hematite	Crude	59.93	.75	.049	.019	2.27	.19	2.26	...
	Ouenza		Hematite	Crude	52.00	4.00	.020	.013	1.30	...	2.00	...
Australia—												
New South Wales	Timezrit	Iron Duke	Hematite	Crude	57.96	12.04	.050	.023	Tr.	1.23	nil.	.71
	Cadia	Cooming Park	Hematite	Crude	55.80	7.45	.055	.172	.54	1.49	.25	1.25
	Carcoar		Alumin.	Concen.	33.48	4.90	Tr.	.100	Tr.	32.00	.36	9.74
Victoria	Wingello	Ballarat	Limonite	Crude	48.10	17.30	...	Tr.	...	4.90	...	7.50
	Nowa Nowa	Iron Mask	Lim. and Hem.	Crude	57.00	20.00	.074	.034	...	...	...	...
Queensland	Cloncurry	Mt. Philp	Hematite	Crude	52.80	23.00	.010	.030	Tr.	.40	Tr.	.10
West Australia	Yampi Sd.	Koolan Island	Hematite	Crude	64.91	7.06	.040	.012	Tr.	2.00	.05	...
		Cockatoo Island	Hematite	Crude	68.99	.95	.008	.010	Tr.	.66	.05	...
	Weld Range	Wilgie Mia	Hematite	Crude	64.36	1.38	.023	.052	...	...	...	.60
	Yilgarn	Mt. Cavelan	Goethite	Crude	60.02	1.90	.026	.056	.43	...	...	...
South Australia	Iron Monarch	Quarry "B"	Hematite	Crude	59.30	1.59	.110	.040	3.00	2.57	...	...
Tasmania	Long Plain	Rio Tinto	Magnetite	Crude	68.50	1.68	.070	.010	...	.18	...	...
	Blythe River	Blythe R. Mine	Hematite	Crude	63.26	7.31	.024	.036	Tr.	1.76	.07	.16
Austria—												
Styria	Erzberg		Siderite	Crude	38.73	4.08	.080	.015	2.45	1.26	5.92	27.62
	Erzberg		Siderite	Calcined	50.88	8.19	.170	.025	3.00	1.61	6.19	2.64
Belgium—												
Namur Liege	Houssois	Rich Ore	Hematite	Crude	45.00	11.00	.150	.480	.13	7.00	4.80	7.00
	Houssois	Poor Ore	Hematite	Crude	25.30	27.00	.150	.370	1.08	12.00	6.50	9.25
Brazil—												
Minas Geraes		Minas Geraes	Hematite	Crude	63.01	1.79	.030	.440	.16	.53	...	6.00
Br. W. & C. Africa—												
Nyasaland	Westshire	Mangui Hill	Hematite	Crude	69.30	.70	nil.	.200	Tr.	...	...	...
Br. West Africa—												
Sierra Leone	Waterloo	Devil Hole	Laterite	Crude	59.91	...	...	...	...	...	...	TiO
Nigeria	Lokoja	Mount Patti	Pisolite	Crude	49.17	7.20	Tr.	.640	...	...	...	12.00
	Bassa	Assadam	Limonite	Crude	47.30	10.58	.080	.060	.01	9.16	.61	8.77
Bulgaria—												
Bossilegrad	Rudin-Kamak		Magnetite	Crude	40.00	31.10	.040	.050	1.50	...	8.90	...
Canada—												
Nova Scotia	Annapolis	Leckie or No. 3	Hematite	Crude	49.20	15.10	.077	.920	.47	4.42	4.94	...
	Antigonish	Arisaig	Hematite	Crude	47.30	17.48	.013	1.49	...	6.80	1.33	...
New Brunswick	Gloucester	Barhurst	Magnetite	Crude	48.20	21.00	.819	.04	...	...	...	...
Quebec	Ottawa	Forsyth	Magnetite	Crude	57.30	10.67	.620	.020	...	...	1.47	...
	St. John	St. Charles	Titanifer	Crude	50.53	...	...	...	...	...	...	Ti
Ontario	Michipicoten	Helen No. 1	Magnetite	Crude	56.79	6.16	.265	.090	.17	.90	.24	10.35
	Sudbury	Moose Mt.	Magnetite	Crude	36.70	45.20	.024	.024	.04	.25	1.06	4.00
	Sudbury	Moose Mt.	Magnetite	Crude	63.02	6.66	.012	.020	.04	1.00	...	...
	Rainy River	Atikokan	Magnetite	Brig.	59.85	8.68	2.010	.110	.11	1.51	3.00	...
British Columbia	Texada Island	Paxton	Magnetite	Crude	64.48	4.47	1.87	.003	...	.66	1.32	...
	Taseko	Iron Creek	Limonite	Crude	46.60	4.00	.88	Tr.	...	...	...	...
	Kamloops	Glen Iron Mine	Magnetite	Crude	64.81	4.21	.100	Tr.	Tr.	3.78	1.00	.66
Ceylon—												
	Kiribatgala		Limonite	Crude	54.59	4.11	.100	.600	.35	2.27	nil.	...

REPRESENTATIVE ANALYSES OF IRON ORES FROM VARIOUS COUNTRIES—(Continued)

Country and Section	District	Grade or Deposit	Type of Ore	Treatment	ANALYSIS						
					Iron	Silica	Sul.	Phos.	Mang.	Alum.	Lime
Chile— Cochimbo		Tofo	Hematite	Crude	67.50	2.50	.010	.060	.20		
China— Chili	Luan-Hsien	Ssu-Chia-Ying	Hematite	Crude	29.00	53.00	.040	.050			
	Hsuan-Lung	Pang-Chia-Pu	Oolitic	Crude	58.41	12.91	Tr.	.150			
Fengtien	Pen-Ch'i-Hsien	Miao-Erh-Kov	Magnetite	Crude	38.83	40.33	.035	.050	.09	2.89	.03
	Kuang-Chang-Ling	Ta-Li-Tzu	Mag. and Hem.	Crude	36.59	47.42	.196	.070			.50
	An-Shan	W. An-Shan	Mag. and Hem.	Crude	38.17	43.72	.011	.034	.10	.34	.62
Hupi	Ta-Yeh	Hsiang-Pi-Shan	Mag. and Hem.	Crude	65.40	3.18	.080	.050	.26	2.00	.40
	O'Cheng	Hsi-Shan	Hematite	Crude	55.70	24.05	.022	.023			
Anhui	Tang-Pu-Hsien	Ta-Wa-Shan	Hem. and Mag.	Crude	58.08	8.48	.090	.450			
Kiangsu	Chiang-Ning-Hsien	Feng-Huang-Shan	Hematite	Crude	59.52	12.18	.040	.070			
Fukien	An-Chi-Hsien	Pan-Tien	Magnetite	Crude	68.43	.66	.058	.010	.73		
Kuangsi	Hong Kong	Ma-An-Shan	Magnetite	Crude	55.82	6.04	.090	Tr.	.50	1.80	.80
Kiangsi	Chen-Men-Shan	Shao-Huo-Shan	Hematite	Crude	32.94	37.54	.980	.200			
Czechoslovakia— Bohemia	Nucitz		Hematite	Crude	35.54	12.52	.270	1.00	.05	7.75	3.35
	Nucitz		Hematite	Calcined	44.30	15.61		1.25	.06	9.66	4.17
Ruthenia	Szepes-Gomor	Iglo	Spathic	Crude	39.43	11.01	.350	Tr.	1.30	.20	.45
		Dobschaw	Brown	Crude	49.24	10.00	.120	Tr.	2.25	2.72	.75
Dutch East Indies— Bornco	Schockoe	Schockoe	Limonite	Crude	50.01	2.35	.180	.04	.37		
Dutch Guiana— Bornco	Donderbary		Latevite	Crude	52.00	8.60				10.00	
Egypt— S. Sinai		Wadi Hallia	Hematite	Crude	23.97				18.66		
			Hematite	Crude	51.53				6.05		
France— Lorraine		Lorraine	Minette	Crude	31.80	7.90		.700		2.30	19.00
		Auboué	Minette	Crude	38.65	6.60		.630		5.50	11.20
		Black Bed.	Minette	Crude	39.90	15.10		.700		5.20	5.90
Normandy		St. Remy	Hematite	Crude	53.21	7.83	.050	1.030		2.97	.42
		Halonze	Hematite	Calcined	49.00	13.50		.700	.65	7.50	3.50
		Dielette	Magnetite	Crude	53.50	8.00		.250			
Brittany-Anjou		Rouge	Hematite	Crude	48.91	15.51	.030	.420	.08	1.40	.16
		Segre	Magnetite	Crude	51.00	14.20		3.00	.30	.90	5.00
Pyrenees		La Pinouse	Hematite	Crude	56.20	2.30		.02	3.00		Tr.
		Thorrent	Carbonate	Calcined	59.33	8.20	.160	.02	2.00		
Germany— East Rhine	Lahn-Dill		Hematite	Crude	45.00	18.00	low	low	.50		
Weser	Bentheim		Hematite	Crude	38.00	12.00	.320	.710			6.00
	Bentheim		Hematite	Roasted	46.50						
Thuringia	Schmiedefeld		Chamosite	Roasted	44.50	25.00		.950			
Great Britain— England	Northampton	Wellingborough	Jurassic	Crude	38.20	17.40	.120	.700	.30	7.20	3.10
	Lincolnshire	Eastwell, etc.	Jurassic	Crude	30.19	13.00	.130	.300	.27	.57	11.42
	Yorkshire	Cleveland	Jurassic	Crude	30.20	12.70	.300	.500	.40	11.00	5.10
	Wiltshire	Westbury	Jurassic	Crude	30.16	10.74	.041	.420		9.68	.68
		Westbury	Jurassic	Calcined	40.00	14.25	.055	.600		12.84	.90
	Yorkshire	Low Moor	Carboniferous	Crude	29.12	17.37	Tr.	.200	1.00	.52	2.70
	Derbyshire	Butterly	Carboniferous	Crude	30.60	10.04	Tr.	.600	1.00	.41	4.53
	Cumberland	Cleator Moor	Carboniferous	Crude	63.25	7.05	Tr.	Tr.		.37	1.06
Wales	Southern	Llanharry	Hematite	Crude	55.59	5.87	.014	.011	.03	.22	3.20

REPRESENTATIVE ANALYSES OF IRON ORES FROM VARIOUS COUNTRIES—(Continued)

Country and Section	District	Grade or Deposit	Type of Ore	Treatment	ANALYSIS								
					Iron	Silica	Sul.	Phos.	Mang.	Alum.	Lime	CO ₂	Water
Greece— Boitio Island of Shyros. Lokris		Lokris Skyros Tsouka	Hematite Hematite Hematite	Crude Crude Crude	47.65 46.20 52.30	7.40 11.20 6.65	.026 .021 .037	.012 .030 .011	.20 .15 .25	13.70 9.49 6.80	.20 .62 .48	.25....95	4.80 5.21 4.60
India— Bengal-Bihar, etc. Central Provinces. Maysore	Singhbhum Mayurbhanj Drug Jubbulpore Chanda Kadur	Pans'ra Hill. Gurumaishini Okampad Rajhara Dijawar Lohara Babadudan Channagiri Kiribatgala	Hematite Hematite Hematite Hematite Hematite Hematite Hematite Limonite	Crude Crude Crude Crude Crude Crude Crude Crude	64.00 60.00 63.11 66.35 56.85 69.21 58.37 56.82 54.59	2.10 5.83 1.50 1.44 8.40 .82 .77 .88 4.11	.002 .030 nil. .108 .022 .047 .049 .100	.050 .080 .030 .060 .080 .005 .060 nil. .600	.02 .42....15..........20 .35	1.25 9.82 1.79 2.27	.15.............13 .72 nil.	... ... ... ... ... ... ... ... ...	
Italy— Tuscany Sardinia	Massa Marittime La Nurra	Vald Aspra Monte Canaglia	Hematite Limonite	Crude Crude	49.00 45.50	9.00 10.00	.150 .140	750	.20 ...	... ...	... ...	... ...	...
Japan— Iwate	Kamaishi Sennin	Kamaishi Sennin	Magnetite Hematite	Crude Crude	60.23 61.55	6.39 11.59	.336 .118	.030 .005	.20 .05	... ...	... ...	... ...	...
Jugo-Slavia— Bosnia	Vares Ljubia	Przitsi Brezik Drozkovats Jazevats Zofa	Hematite Limonite Carbonate Brown Brown	Crude Crude Crude Crude Crude	65.07 48.70 45.93 49.12 59.42	4.14 6.28 6.55 13.75 2.80	.040 .120 .300 .054 .026	.040 .250 .020 .160 .220	.53 2.00 5.08 2.37 2.68	1.00 1.35	.48 .70 ... ... ...	... ... ... ... ...	...
Luxemburg— Southern	Lorraine	Yellow Ore Brown Ore	Brown Brown	Crude Crude	38.00 24.00	9.00 16.60	... ...	.300 .600	.75 1.00	4.20 6.50	9.80 8.60	... ...	...
Mexico— Western	Durango Michoacan	Cerro del Mercado Las Truchas	Hematite Hematite	Crude Crude	65.00 63.92	3.00 6.00	.020 .027	.200 .050	.15 .03	54	50	... ...	2.00
Morocco— Melilla		Navarete	Hematite	Crude	54.00	11.00	.100	.030	.50	...	2.00	...	...
Newfoundland— Bell Island	Conception Bay	Wabana	Hematite	Picked	53.86	9.48	.018	.850	.65	3.55	1.81	4.32	4.32
New Zealand— South Island North Island	Parapara	Washburn New Plymouth	Limonite Mag. Sand	Crude Concen.	51.78 56.87	9.56 3.90	.080 .004	.150 .390	.30 .15	3.36 4.00	.51 1.80	.10 ...	11.84 .25
Norway— Northern Southern	Sydvaranger Sydvaranger Rodsand Rodsand Lunkanfjord Lunkanfjord	Dunderland Dunderland Bloafjeld Bloafjeld Hindo Hindo	Magnetite Magnetite Magnetite Magnetite Magnetite Magnetite	Crude Concen. Crude Concen. Crude Concen.	36.17 66.25 46.50 64.00 27.88 66.89	44.93 6.30 10.00 2.50 ... 4.92	.009 .012 .900 .620 .360 .080	.090 .012 .020 .010 .240 .030	.08 .10	.60 .44	2.20 .60 TiO ₂ TiO ₂	 6.50 2.50 ... ...	... ... ... ... ... ...
Peru—	Ica	Marcona	Hematite	Crude	63.00	3.50	.030	.030	...	...	...	...	...
Persia—	Huancayo	Huacavilca	Hematite	Crude	68.50	7.50	1.00	...	...	...	...	...	...
	Kuh-i-Girdu	Durdur	Hematite	Crude	65.69	...	...	.160	...	...	...	...	...

REPRESENTATIVE ANALYSES OF IRON ORES FROM VARIOUS COUNTRIES—(Continued)

Country and Section	District	Grade or Deposit	Type of Ore	Treatment	ANALYSIS							
					Iron	Silica	Sul.	Phos.	Mang.	Alum.	Lime	CO ₂
Philippines— Mindanao	Surigao	Surigao	Brown	Crude	58.20	1.04	Tr.	Tr.	Tr.	10.56	Tr.	Tr.
Luzon	Camaching	Camaching	Magnetite	Crude	62.50	5.02	.020	.050	.10	4.80	.35	1.10
Portugal— Trasos Montes	Moncorvo		Mag. and Hem.	Crude	40.50	36.50	low	.280	Tr.	Tr.	Tr.	Tr.
Alemtojo	Serra dos Monges	Monges	Magnetite	Crude	54.00	6.50	.200	.011	.80	Tr.	Tr.	Tr.
	San Thiago	Pequito	Magnetite	Crude	58.50	7.00	.042	.006	.20	2.83	1.00	Tr.
Rhodesia— Southern	Victoria Falls		Hematite	Crude	50.00	13.49	nil.	nil.	nil.	3.10	.23	10.80
	Enterprise	Iron Mine Mill.	Magnetite	Crude	63.40	6.54	Tr.	Tr.	3.40	Tr.	Tr.	Tr.
Rumania— Banat	Krasso-Szorenver	Vasko	Magnetite	Crude	57.58	11.48	Tr.	.100	.29	1.69	2.96	Tr.
		Doynacska	Magnetite	Crude	41.19	17.35	.220	.070	Tr.	6.46	7.80	Tr.
Hunyad	Also-Telek	Also-Telek	Limomite	Crude	45.10	17.10	.030	.020	3.24	.95	4.40	Tr.
	Also-Telek	Also-Telek	Siderite	Crude	34.60	18.91	.030	.040	1.51	.44	9.98	Tr.
	Ploszka	Ploszka	Limomite	Crude	68.70	10.41	.100	.060	3.86	1.32	5.13	Tr.
Russia— Southern	Krivoi Rog	Kopolov	Hematite	Crude	64.70	6.13	.060	.030	.010	.25	.18	Tr.
	Kertch	Yellow Ore	Limomite	Crude	42.00	13.00	Tr.	1.00	1.00	Tr.	Tr.	Tr.
Urals	Gora Blagodat		Magnetite	Crude	53.89	9.40	.050	.150	.100	Tr.	Tr.	Tr.
	Slatoust		Limomite	Crude	62.51	4.00	Tr.	Tr.	.20	2.20	.46	Tr.
Spain— Cantabrian-Cordillera	Gora Magnitnaia		Mag. and Hem.	Crude	60.00	12.00	.930	Tr.	2.00	3.50	Tr.	Tr.
	Lugo	Vivero	Magnetite	Crude	49.00	14.00	.100	.500	1.00	Tr.	Tr.	Tr.
	Leon	Meira	Carbonate	Crude	48.00	17.00	.060	1.100	.07	Tr.	Tr.	Tr.
			Hematite	Crude	52.35	6.67	.082	.750	.15	6.03	.55	Tr.
	Oviedo	Careno	Siderite	Crude	49.04	6.00	.039	.800	.30	4.24	1.44	Tr.
	Santander	Obregon	Hematite	Crude	52.44	15.34	.200	.400	.10	4.27	.44	Tr.
	Vizcaya	Anita	Brown	Washed	58.80	3.80	.073	.030	.33	.50	.50	Tr.
		Rubio	Brown	Crude	47.01	9.40	.063	.040	.60	1.18	1.13	Tr.
		Rubio	Brown	Crude	53.17	11.16	.035	.018	.60	1.25	.60	Tr.
		Rubio	Brown	Washed	57.69	2.99	.063	.037	Tr.	Tr.	Tr.	Tr.
		Rubio	Brown	Crude	56.83	9.53	.445	.015	Tr.	Tr.	Tr.	Tr.
		Aneto	Magnetite	Crude	68.00	3.50	.300	.100	Tr.	Tr.	Tr.	Tr.
	Nararra	Aneto	Magnetite	Crude	57.00	3.50	Tr.	.020	Tr.	Tr.	Tr.	Tr.
	Saragossa	Calatayud	Hematite	Crude	65.45	1.70	.020	.013	.18	1.51	2.10	Tr.
Sierra Menera	Terval	Almohaja	Hematite	Crude	54.75	6.20	.020	.226	1.90	Tr.	Tr.	Tr.
Sierra Morena	Huelva	Rio Tinto	Bog Ore	Crude	59.26	1.53	.230	.060	Tr.	Tr.	Tr.	Tr.
	Sevilla	La Lima	Magnetite	Crude	61.33	8.53	.100	.011	Tr.	Tr.	Tr.	Tr.
South Coast	Malaga	Marbella	Magnetite	Crude	61.17	8.65	.090	.018	Tr.	.24	.50	Tr.
	Granada	Tesorero	Hematite	Crude	61.32	6.40	.010	.010	1.78	Tr.	Tr.	Tr.
	Almeria	Alquife	Spathic	Crude	52.50	5.00	.036	.014	Tr.	Tr.	Tr.	Tr.
		Olulade Castro	Spathic	Crude	57.90	7.93	.013	.013	1.07	Tr.	Tr.	Tr.
	Murcia	Morata	Hematite	Crude	50.00	4.50	.020	.020	2.00	Tr.	Tr.	Tr.
Sweden— Norrbotten	Kiirunavaara	Class "A"	Magnetite	Crude	69.50	1.70	.020	.020	.20	.32	.23	.40
	Gellivaara		Magnetite	Crude	69.37	2.29	Tr.	.300	.10	1.08	.61	Tr.
Switzerland— Aargau	Fricktal		Limomite	Crude	30.00	16.65	.030	.510	.24	6.50	10.80	10.50
Transcaucasia— Georgia	Tchatakh	Damir-dagh	Hematite	Crude	59.25	Tr.	.210	.020	Tr.	Tr.	Tr.	Tr.
Tunisia— Djerissa-Slata			Hematite	Crude	55.02	1.35	.008	.013	2.32	.44	4.13	5.55
			Hematite	Crude	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.	3.90

REPRESENTATIVE ANALYSES OF IRON ORES FROM VARIOUS COUNTRIES—(Continued)

Country and Section	District	Grade or Deposit	Type of Ore	Treatment	ANALYSIS									
					Iron	Silica	Sul.	Phos.	Mang.	Alum.	Lime	CO ₂	Water	
United States— Superior	Vermilion	Vermilion	Hematite	Crude	62.06	7.85	....	.120	.08	....	....	....	1.00	
	E. Mesabi	Zenith	Hematite	Crude	61.90	7.16	.010	.040	.09	2.60	.30	....	6.00	
		Babbitt	Taconite	Crude	33.80	45.17	....	.050	.60	.67	....	....	1.50	
		Mesabi	Mahoning	Sinter	Crude	64.00	9.00	.005	.027	.20	.67	.10	....	
	Mesabi	Biwabik	Hematite	Crude	63.89	2.79	.013	.040	.30	1.50	.14	....	8.48	
		Alexandria	Hematite	Crude	60.90	4.96	....	.050	.80	1.34	....	....	10.13	
		Majorca	Hematite	Crude	56.10	5.45	.010	.100	1.37	1.90	.20	....	12.65	
	W. Mesabi	Majorca	Hematite	Crude	46.00	25.00	....	.070	....	....	....	....	8.00	
		Kennedy	Hematite	Washed	57.60	13.46	.010	.060	.11	1.17	.24	....	9.30	
		Croft	Hematite	Crude	55.40	10.22	.016	.220	.31	2.23	.37	....	10.13	
Northeastern	Cuyuna	Millford	Hematite	Crude	60.05	9.98	.005	.040	.09	1.90	.36	....	18.59	
	Goyebic	Montreal	Hematite	Crude	42.40	6.15	.007	.260	11.44	3.87	.36	....	11.95	
	Menominee	Ontario	Hematite	Crude	61.00	7.80	.010	.040	.40	2.33	.20	....	9.90	
		Davidson	Hematite	Crude	52.75	9.20	.010	.060	6.00	1.40	.35	....	6.90	
		Manganate	Limonite	Crude	56.69	5.30	.060	.480	.19	2.23	.40	....	7.35	
	Marquette	Vulcan	Hematite	Crude	49.60	6.60	.110	.630	3.65	2.98	4.84	....	5.00	
		Stephenson	Hematite	Crude	55.10	8.50	.023	.045	.27	1.25	1.92	....	13.50	
		Richmond	Hematite	Crude	59.77	6.32	.017	.250	.65	2.43	1.00	....	2.89	
	Baraboo	Republic	Hematite	Crude	39.70	39.36	.009	.050	.06	1.13	.47	....	.25	
		Cahoon	Hematite	Crude	65.05	6.04	.010	.060	.04	.82	.16	....	10.00	
Mayville		Hematite	Crude	53.84	14.61	.010	.070	.30	3.82	.10	....	11.39		
Southern	Adirondack	Mayville	Hematite	Crude	44.40	4.95	.180	1.410	.11	3.94	6.88	....	2.00	
	Hudson Highlands	Lyon Mt.	Magnetite	Concen.	61.00	10.00	.026	.009	.09	1.36	1.45	....	....	
		Old Bed 21	Magnetite	Crude	60.53	5.62	Tr.	1.260	.05	1.14	5.38	....	....	
		Sanford Lake	Titanifer	Crude	50.52	....	....	.009	....	....	....	11.71	....	
	Pennsylvania	Ramapo	Magnetite	Crude	56.00	8.00	.023	.900	.25	2.30	4.70	....	....	
		Cornwall	Magnetite	Crude	51.45	12.27	2.460	.010	.07	1.10	2.60	....	....	
		Eastern	Carbonate	Crude	44.50	23.00	.800	.570	.62	4.45	5.90	....	....	
	Birmingham	Ishkooda	Hematite	Crude	36.82	17.90	....	.370	.16	3.03	13.67	....	1.00	
		Giles	Brown	Crude	50.39	13.42	....	.310	.82	2.41	....	....	5.38	
		Iron Mountain	Hematite	Concen.	55.00	7.00	low	low	....	....	....	....	....	
Western	Texas	Eastern	Brown	Crude	46.63	14.47	.083	.170	.70	8.17	....	....	....	
	Wyoming	Hartville	Hematite	Crude	66.13	2.90	....	.040	....	....	....	....	....	
		Iron Springs	Hem. and Mag.	Crude	56.00	7.00	.057	.200	.20	1.00	4.00	....	3.00	
		California	Eagle Mt.	Hematite	Crude	64.00	3.30	.060	.050	.18	.20	1.05		1.20
	Montana	Great Falls	Hematite	Crude	64.76	4.83	.032	.015	.31	.15	....	....	....	
		Timeball	Martite	Crude	47.55	24.10	.030	.200	....	3.25	.70	....	3.95	
		Magnet Heights	Magnetite	Crude	60.20	3.00	....	.100	....	....	TiO	14.30	....	
	Natal	Buffelschock	Hematite	Crude	66.23	3.35	n l.	.030	....	....	....	....	....	
		Kromdraaic	Hematite	Crude	64.08	7.40	.030	.020	Tr.	.75	Tr.	....	....	
		Umhlutuzi	Hematite	Crude	50.00	6.08	....	.300	1.20	....	....	....	.72	
Uruguay— Venezuela— West Indies— Porto Rica	Rivera	Zapucay	Manganifer	Crude	35.00	9.00	.050	.030	23.00	....	....	....	....	
	Imataca	Manoa	Hematite	Crude	66.53	1.81	.045	.030	....	....	....	....	....	
		Colon	Hematite	Crude	59.37	7.35	.072	.190	.07	....	....	....	....	
		Oriente	Mayari	Brown	Crude	46.03	5.50	.060	.100	.56	10.33	Cr.1.7	Ni.5	45.35
	Mayari		Nodules	Sintered	55.00	4.50	Tr.	.040	....	13.00	Cr.2.0	Ni.1.0	....	
	Moa		Brown	Crude	46.20	3.73	....	.010	....	12.23	....	....	....	
	Camaguey	Daiquiri	Mag. and Hem.	Crude	60.00	9.00	1.00	.030	.08	.75	1.00	....	....	
		San Felipe	Brown	Crude	44.00	6.95	....	....	....	12.30	....	....	....	
		Mayaguez	Limonite	Crude	40.60	2.44	....	....	....	....	Tr.	....	14.00	

carrying from 40 to 65 per cent of iron in eastern Siberia, but there has been little exploration and no development so that little is known regarding their size, and the quality of the ore although it is quite probable that there is a large tonnage available.

Australia.

Iron ore deposits are found well scattered over Australia but the largest ones are in South and West Australia. The Iron Knob and Iron Monarch and the Iron Prince and Iron Baron deposits are in South Australia near Lake Gilles. The ore is a high grade hematite averaging 64.40 per cent in iron and 2.14 per cent in silica that can be mined by open quarries. There are about 18 small deposits of hematite, magnetite, and brown ore scattered through the rest of South Australia but none of them are very large. The

APPROXIMATE IRON ORE PRODUCTION OF
VARIOUS COUNTRIES.

Country	1913	1917	1920	1923
NORTH AMERICA				
Canada	279,100	195,300	117,100	27,900
Cuba	1,607,700	562,300	897,000	685,200
Newfoundland	1,456,900	801,200	590,800	1,200,000
United States.	62,972,100	76,493,500	68,689,500	70,464,500
SOUTH AMERICA				
Chile	14,100	5,000	.....	679,200
Venezuela ...	58,100	.....	.....	.....
EUROPE				
Austria-Hung.	5,318,500	3,744,700	.....	.....
Austria .....	.....	.....	435,100	1,211,100
Belgium	150,400	17,000	17,300	87,500
Czechoslovakia	.....	.....	1,053,100	?
Finland .....	.....	.....	12,900	?
France	21,917,900	2,034,700	13,921,800	23,428,200
Germany	28,607,900	22,464,800	6,354,300	?
Greece	313,600	63,400	45,600	100,100
Hungary .....	.....	.....	101,700	?
Italy	603,100	993,800	389,900	340,800
Luxemburg ..	7,333,400	4,502,700	3,704,400	4,097,500
Norway	544,700	302,700	79,200	?
Poland .....	.....	.....	120,000	450,200
Portugal	49,200	7,400	12,800	?
Rumania .....	.....	.....	79,800	99,300
Russia	9,513,900	?	170,400	487,000
Spain	9,861,700	5,551,100	4,767,700	3,456,200
Sweden	7,475,600	6,217,200	4,519,100	5,597,700
U. Kingdom .	16,254,100	15,084,000	12,910,800	11,049,800
Jugo-Slavia .	.....	.....	1,100	244,600
ASIA				
China	459,700	639,800	1,379,500	?
Korea	142,000	140,600	454,400	243,200
India	376,800	420,000	566,900	817,300
Indo China ..	.....	.....	2,400	?
Japan	171,700	?	203,600	?
Malay States.	.....	.....	.....	156,600
AFRICA				
Algeria	1,348,900	985,300	1,071,300	1,452,600
Belg'm Congo	.....	.....	79,700	?
Morocco .....	.....	.....	211,900	396,700
Rhodesia .....	.....	4,800	.....	.....
Tunisia	597,500	606,000	406,300	845,000
U. of S. Africa	.....	.....	2,300	500
OCEANIA				
Australia	178,600	457,000	605,500	572,100
Total Production	177,609,000	142,294,000	123,976,000	128,192,000

hematite deposits of Koolan and Cockatoo Islands in Yampi Sound are the largest in Western Australia and the ore averages from 52 to 69 per cent in iron. Other deposits of high grade ore occur at Wilgie Mia, Mt. Caudan, Mt. Gibson, and Delaney. In New South Wales the Cadia deposit of hematite and magnetite ore, carrying 53 to 62 per cent of iron, is by far the largest in the state. Many other small deposits of

hematite, magnetite and brown ore are scattered throughout this state but none of them are large. The Cloncurry district in Queensland contains several large deposits of hematite ore carrying from 53 to 62 per cent of iron. The deposits in Victoria are all small although deposits of limonite are found at Lal Lal, Nowa Nowa, and Mirboo. There are two fairly large deposits of ore in Tasmania at Long Plain and Blythe River. The Long Plain deposit contains magnetite ore carrying from 63 to 69 per cent of iron and the Blythe River deposit contains hematite ore. Australia produces from 500,000 to 700,000 tons of iron ore annually most of which comes from South Australia.

New Zealand.

On the South Island of New Zealand there is a large deposit of limonite ore carrying from 44 to 59 per cent of iron at Parapara and along the west coast of the North Island there are several deposits of titaniferous sand. New Zealand has never developed its iron ore resources.

Philippine Islands.

A very large body of laterite or brown ore much like the Mayari ore of Cuba occurs at Surigao on the Island of Mindanao. This ore carries about 47.40 per cent iron, 13 per cent water, 10 to 12 per cent alumina, and is low in silica, sulphur, and phosphorous. Up to the present time this deposit has not been developed.

Dutch East Indies.

There is a large body of laterite ore at Seboekoe and at Soengei Doewa in Borneo which contains from 50 to 54 per cent of iron before calcining. This deposit is now being developed. On the Island of Celebes there is a large deposit of laterite ore carrying 49 per cent of iron but it has never been worked. Several small deposits of magnetite ore are reported on Sumatra but they are not important at present. A deposit of limonite ore carrying 56 per cent of iron occurs in British Borneo but it is undeveloped.

Brooklyn Polytechnic

An event of interest to engineers and chemists generally will take place on the evening of January 13, 1926, in the Opera House of the Academy of Music, Brooklyn, N. Y., when Dr. Parke Rexford Kolbe will be installed as the new President of the Polytechnic Institute.

Dr. Charles Alexander Richmond, president of Union College will give the principal address of the evening. The presentation of the charter, seal and keys will be made by Charles E. Potts of the class of 1892, and now Chairman of the Board of Trustees of the Polytechnic. President Kolbe will follow with his inaugural address. Other speakers will be Dr. William H. Nichols, Chairman of the Board of the General Chemical Company and for many years chairman of the Corporation of the Polytechnic; Dr. George S. Collins, senior member of the faculty, and Bancroft Gherardi, Chief Engineer of the American Telephone & Telegraph Company.

The Polytechnic Institute of Brooklyn is one of the oldest colleges of Engineering in the country, having been established in 1854. It grants the degrees of Civil, Electrical, Mechanical and Chemical Engineer, as well as B. S. and M. S. in Chemistry.

By-Product Coke and Gas Industry

By C. J. RAMSBURG†

DURING the year 1925, additional coking capacity of approximately 3,000,000 tons was installed by the By-Product Coke Industry and the Gas Industry, at the following plants:

was the completion at Troy, N. Y., of a battery of Foundations ovens. As this is the first installation of ovens of this type in the United States, operating results will be watched with considerable interest by

Name	Location of Plant	Type of Oven	Number Ovens	Coal Carb. Cap. Tons
By-Products Coke Corporation.....	South Chicago, Ill.	Becker	110	1,000,000
Alabama By-Product Coke Corporation.....	Birmingham, Ala.	Koppers	25	170,000
*Lynn Gas & Electric Company.....	Lynn, Mass.	Becker	11	54,000
*North Indiana Gas & Electric Company.....	Fort Wayne, Ind.	Becker	19	94,000
*Consumers Power Company.....	Jackson, Mich.	Becker	15	47,500
Woodward Iron Company.....	Woodward, Ala.	Koppers	40	235,600
Republic Iron & Steel Company.....	Birmingham, Ala.	Becker	57	720,500
Hudson Valley Coke & Products Corporation.....	Troy, N. Y.	Foundation	44	400,000
Perry Iron Company.....	Erie, Pa.	Wilputte	37	300,000
Under construction:				
Illinois Steel Company.....	Gary, Ind.	Becker	138	1,259,250
Jones Laughlin Steel Corporation.....	Aliquippa, Pa.	Becker	122	1,100,000
Jones Laughlin Steel Corporation.....	Hazelwood, Pa.	Becker	60	438,000
Consolidated Gas Company.....	Hunts Point, N. Y.	Becker	74	638,750
Inland Steel Company.....	Indiana Harbor, Ind.	Becker	73	620,916
Wheeling Steel Corporation.....	E. Steubenville, W. Va.	Becker	51	347,000
*Rochester Gas & Electric Corporation.....	Rochester, N. Y.	Willputte	37	163,865
*Utica Gas & Electric Company.....	Utica, N. Y.	Becker	21	104,244

*Small oven gas plants.

A review of this construction shows that most of the additional capacity was provided by Becker type ovens. An interesting feature of the year, however,

the Industry at large. At this time, however, it is too early to give any figures regarding results.

By virtue of its large unit capacity, the newly erected plant of the Republic Iron & Steel Company at Thomas, Ala., is significant of the trend in the In-

†Vice President, The Koppers Company, Pittsburgh, Pa.

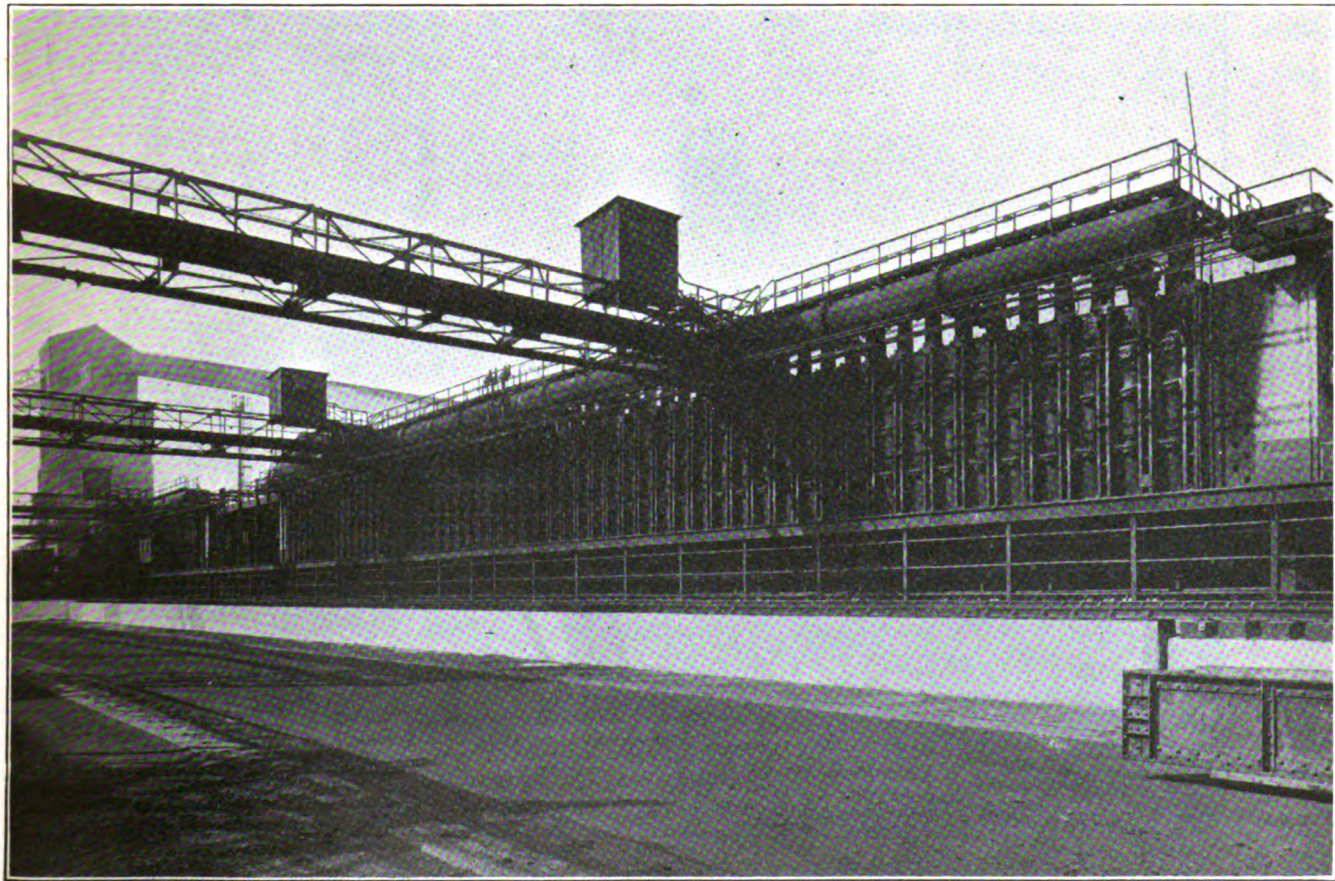
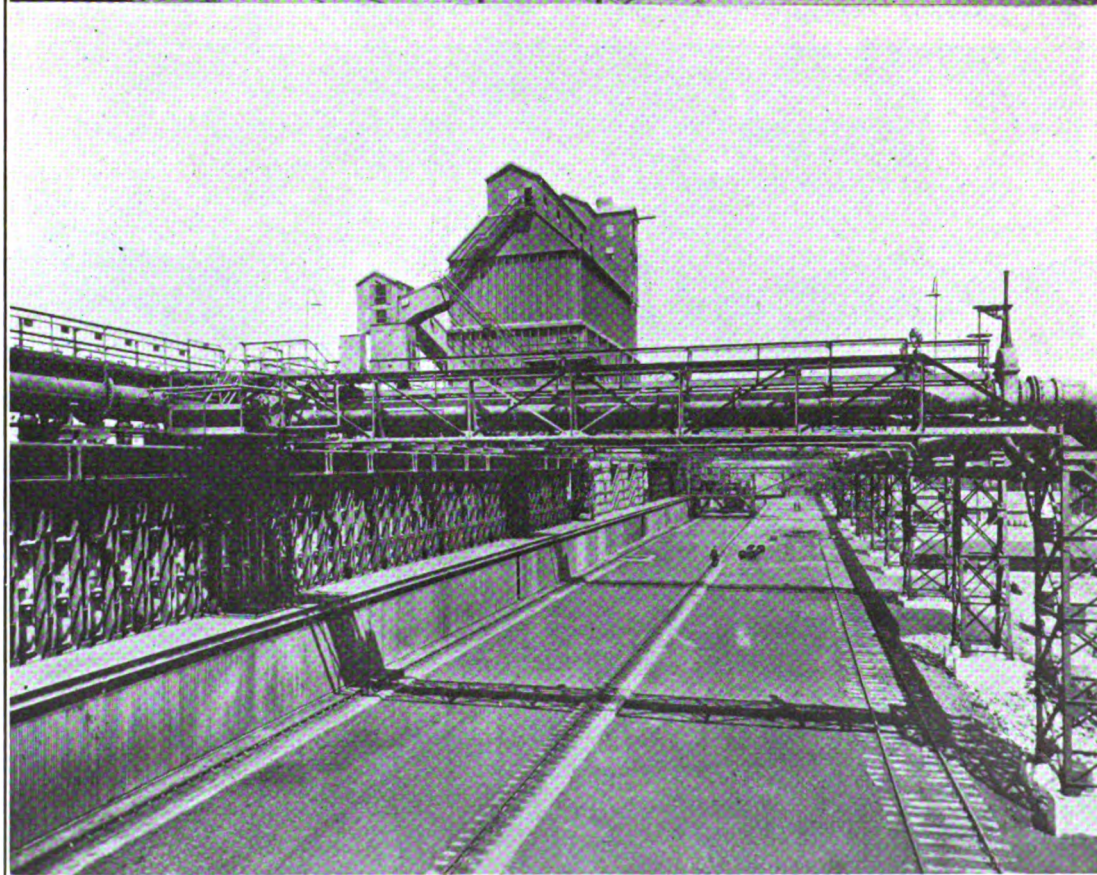
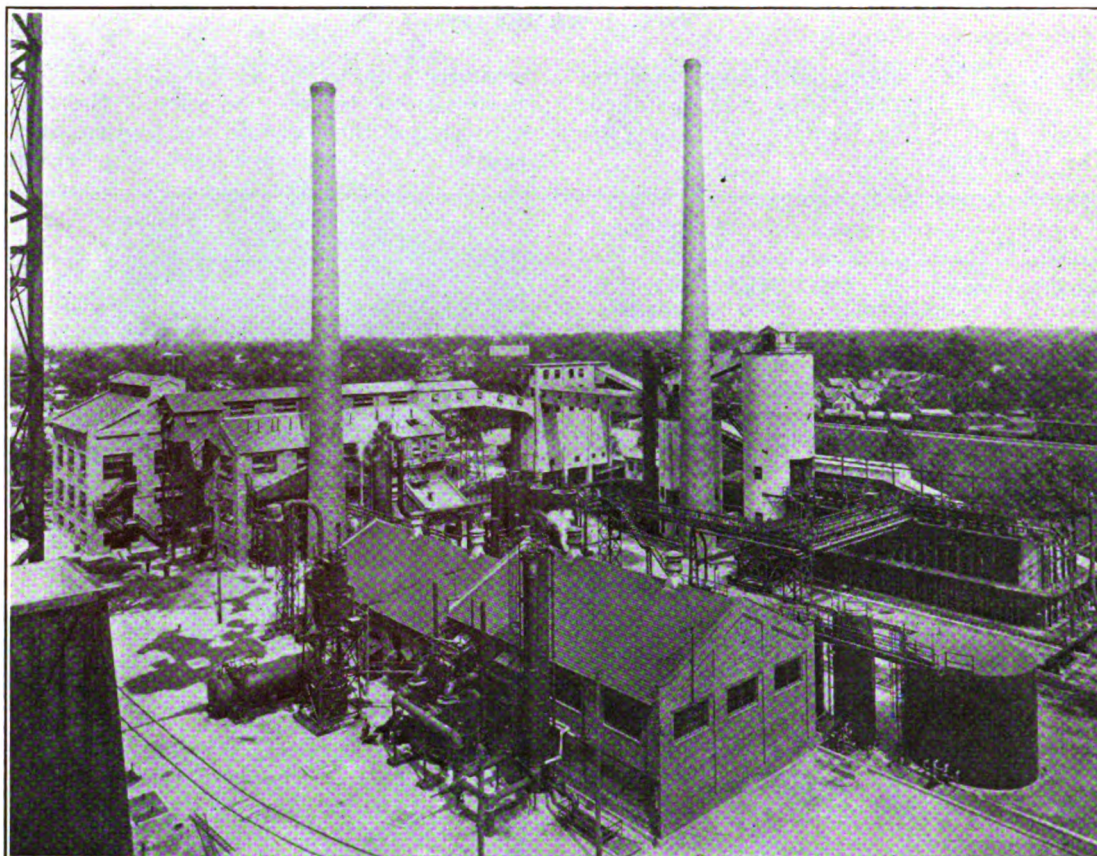


FIG. 1—Installation of Becker type ovens in the Buffalo district.

Plant of Northern Indiana Gas and Electric Company, Ft. Wayne, Ind.



Plant of By-Products Coke Corporation, South Chicago, Ill.

dustry toward larger ovens. While the desirable 14 in. width is used, the ovens are built to hold approximately 15.5 tons of coal and to handle 31 tons per day when operating on their normal carbonizing time of 12 hours. It is interesting to note that this is the largest unit capacity installed to date in any plant in the world.

In addition to the plants in operation, there were under construction as of January, 1926, the plants previously noted with the capacities shown.

As in previous years, all of the Becker oven capacity was in the combination type oven, which can

be heated with oven gas, producer gas, blast furnace gas, or blue water gas. In this way coke oven operators are assuring themselves that increased future demands for coke oven gas as fuel, will be met in the most economical manner. A striking instance of the value of such forethought, is evidenced by the building this year, of a producer plant for the Laclede Gas Light Company, to provide producer gas for heating combination ovens built for them by The Koppers Company more than ten years ago. In this case, the demand for gas had increased without a corresponding increase in the demand for coke.

Relation of Carbon Consumption to Material Smelted in the Blast Furnace*

By S. P. KINNEY†

THIS paper discusses the relation of carbon consumption in the iron blast furnace to the quantity of material smelted and the effect of high ash coke. The data presented was compiled from the records of a 300-ton furnace operating in the Southern district. This furnace produced foundry iron from a mixture of Southern red hematite, brown ores, and nodules made from pyrite sinter. On account of certain changes at the company's coal mining and washing plant it was found desirable to operate the furnace on high ash coke for a short period. This afforded an opportunity to obtain some information as to the effect of high ash coke on blast-furnace opera-

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(Concluded on page 24)

Operating data during 10 months run.

Operating results	March	April	May	June	July	August	September	October	November	December
1. Iron produced, tons	7330	6515	8393	8333	8249	7802	9428	8993	9098	8652
2. Ore nodules and scrap per ton of iron, lb.	6207	5869	5561	5717	5586	5514	5067	5115	5068	5354
3. Limestone per ton of iron, lb.	2258	2438	2170	1511	1769	1769	1096	1212	908	947
4. Coke per ton of iron, lb.	3788	3879	3605	3427	3362	3616	2975	3090	2903	3197
5. Raw materials smelted per ton of iron, lb. ^a	8958	8813	8234	7693	7788	7833	6595	6913	6479	7017
6. Analysis of coke, per cent:										
Fixed carbon	86.98	86.95	86.06	86.45	87.11	84.80	85.53	81.05	82.66	77.60
Ash	11.89	12.01	12.76	12.62	12.10	14.05	13.53	17.45	16.20	21.30
Volatile matter	1.13	1.04	1.18	0.93	0.79	1.15	0.94	1.50	1.14	1.10
Sulfur	0.70	1.01	1.02	1.04	0.95	0.94	0.99	0.86	0.90	0.90
7. Carbon per ton of iron, lb.	3295	3373	3102	2962	2929	3066	2545	2504	2400	2481
8. Raw material smelted per pound of coke, lb.	2.46	2.28	2.28	2.31	2.32	2.16	2.22	2.24	2.23	2.20
9. Raw material smelted per pound of carbon, lb.	2.72	2.61	2.65	2.59	2.66	2.55	2.69	2.76	2.70	2.82 ^b
10. Deviation from average — quantity of material smelted per pound of carbon, per cent.	+1.68	-2.43	-0.94	-3.18	-0.56	-4.67	-0.56	+3.18	+0.94	+5.42

^a Includes ore, nodules, limestone, ash in coke, and volatile in coke.
^b Average = 2.67 pounds.

Blast Furnace Progress in 1925

By H. E. McDONNELL*

IF there is any distinction due the year just passed in the way of progress in blast furnace operation, construction, or design, it lies in the extent in which different furnace interests have travelled with more confidence along paths previously explored.

As more recent operating and construction innovations have proved more definitely successful, their adoption has become more rapid and general.

Furnaces Show Increased Output.

The past year has witnessed a notable increase in pig iron production on a great many furnaces and the results have proved themselves sufficiently encouraging so that 1926 should be a year that will profit greatly by the experiences of 1925.

Seven hundred tons of pig iron a day without the use of outside scrap has become almost as common in the past year as 600 tons a day was only a few years ago, and next year will, no doubt, witness an appreciable increase in the number of furnaces over the 700 ton mark.

This increased tonnage has been made possible by larger hearth diameters with improvements in general design resulting therefrom, by more careful selection of raw materials entering the furnace, by increased blowing and stove capacities and by more careful operation and manipulation of the furnaces as regards the blast regulation, stock distribution and general handling.

Progress in Furnace Design.

Furnace hearth diameters of 20 feet and over are now being built with confidence and hearth diameters of 21 ft. 6 in. have consistently demonstrated their practicability.

The gradual increase in hearth diameters together with the tendency toward the elimination of the furnace bosh has almost always resulted in notably smoother furnace operation, increased tonnage and overall economy but without any appreciable decrease in coke consumption.

In design and construction, the general tendencies have been toward larger and stronger furnaces the total furnace height remaining at about 95 ft. in the larger installations.

Where increases in hearth diameter have been generally followed, the increases in stock line and large diameter bells have as yet been approached very cautiously, although with the large cubical content furnaces now being built it is felt that the time has come when larger stock line diameters will soon be found necessary to accommodate the increased tonnages of raw materials charged and the additional volumes of furnace gas given off.

It is realized more generally that where independent skip structures had their advantages in relieving the furnace top of the load of the upper end of the skip incline, the suspension of the furnace bells from the top of the independent skip often resulted in the movement of the bells away from the center line of the furnace. To eliminate this trouble, skip inclines are

more generally being either fastened to the furnace top structure, or the skips are left self sustaining and the bells swung from the furnace top structure in order to be unaffected by any skip movement.

The top structures have in several cases been supported by the gas uptakes which are made extra heavy and brick lined to serve the twofold purpose of gas conduits and structural members.

Furnace shells are being built with a tendency toward increasing thickness, with heavy-strap joints, the heavier shells serving the twofold purpose of affording general strength and supporting the heavier furnace tops.

In the hearth and bosh the tendency is toward heavier construction, not only of the hearth jacket, tuyere jacket and bosh bands, but also of the furnace foundations surrounding the hearth jacket and column bases.

Hot Blast Stoves Stronger.

Hot blast stove design has taken a definite swing back toward structural strength of the brick work, even at the expense of some heating surface. Where small checker openings and thin checker brick yielded the maximum of brick weight and heating surface in a stove shell, the best and most economical operating results are calling for thicker brick and larger checker openings, the decrease in heating surface being made up by an increase in the diameter, or in the height of the stove, or both.

Heavier stove shells are being favored in some cases to meet the demands of higher blast pressures and increased wind volume.

Burning furnace gas in the hot blast stoves under pressure has become more common in the past year, the advantage being a more uniform mixture of gas and air, a greater volume of gas burned per unit of time, and a more uniform distribution of hot gases throughout the checker work of the stove. The increased heating of the stoves is due as much to the increased gas volume burned and the gas distribution as to the uniformity of the gas and air mixtures.

Improved Raw Materials.

The past year has seen considerable progress in the matter of raw materials charged into the blast furnace, and the assembly of more carefully selected materials has made it possible at several plants to increase their furnace output markedly.

Closer Co-operation Between Coke Plants and Furnaces.

One of the most encouraging points of progress in the past year is the closer approach toward a clear understanding between blast furnace operators and coke producers and between plant executives and coke plant and furnace operators as to the most economical and profitable manufacture and use of blast furnace coke.

It is becoming more generally recognized that local considerations govern the question of coke quality required for certain desired furnace results and the realization that certain definite coke qualities, both

*Superintendent, Blast Furnace Department, Weirton Steel Company, Weirton, W. Va.

physical and chemical, should be aimed at to obtain these certain desired local furnace results has led to an increased closeness in co-operation between the coke plant and blast furnace operators.

The past year has seen some real progress in the efforts of blast furnace operators to get away from generalities in their judgment of coke and to express in as definite, specific detail as possible what their coke requirements are and why.

Where definite coke qualities have been asked for and where these requirements have been met by the coke plant operators, the beneficial results to both coke and furnace plants have in several definite instances, been very marked.

The era of "Coal is Coal" and "Coke is Coke" is passing. The idea that a given coke found to be satisfactory and economical on one plant must necessarily be satisfactory and economical on a different plant, under different conditions, is also passing.

The idea that the blast furnace operator cannot state what he does want, and that the coke plant operators either cannot, or does not try to fulfill blast furnace requirements is passing rapidly.

The year 1925 has seen several definite and profitable demonstrations well known in coke plant and blast furnace circles where an intelligent statement of coke requirements by the furnace operator and the meeting of these requirements by the coke plant operator, have led to improvements in practice and economies in production previously thought almost impossible.

Review of the Year.

Looking back over the last twelve months a few things seem to be definitely settled that were not so clear a year ago.

The large blast furnaces with hearth diameters from 20 to 21 ft. 6 in. have justified themselves in so many cases and in different locations, from a standpoint of smoother operation, increased tonnage and overall economy that they may safely be said to have passed out of the experimental stage.

The gradual elimination of the furnace bosh by further increase in hearth diameter and bosh angle together with the reduction of bosh height is spoken of more generally as a desirable aim in furnace design, and the total elimination of the furnace bosh is an eventual possibility in the opinion of more than one prominent blast furnace operator.

Also the possibility of being able to build and equip a blast furnace and supply it with selected raw materials to produce a 1,000 tons of pig iron a day seems to be less a wild fancy than it did a few short years ago.

The past year has witnessed several definite cases of material improvement in coke plant and blast furnace operations and practice due to a concerted effort on the part of the furnace operators to study their coke requirements very carefully and then state clearly and intelligently their wants and reasons therefore in a way that is consistent with their local conditions, overall economies and reasonable possibilities which unfortunately has not always been done in the past.

Where this has been done the response on the part of the plant management and coke plant operators has generally been forthcoming and the results have been profitable to all concerned.

As an example of the earnest effort being made by coke plant and blast furnace operators and designers to get closer together in a mutual understanding of their common problems, such organizations as the Eastern States Blast Furnace and Coke Oven Association, The Blast Furnace and Coke Association of the Chicago District and the Southern Ohio Pig Iron and Coke Association have been making considerable progress in bringing together coke plant and blast furnace operators and designers from all parts of the country in frequent and well attended meetings.

These meetings have been very successful in bringing out carefully prepared and authoritative papers on subjects of particular interest to the members and in promoting free, outspoken exchanges of ideas and opinions with generous statements of experiences, giving the members increased interest, enthusiasm and help in attacking the various problems that continuously have to be met.

The coke plant and blast furnace fraternity is greatly indebted to the Department of Commerce Bureau of Mines for their earnest, painstaking studies of the coke plant and blast furnace problems.

Krupp's Withdraw from German Combine

The great German industrial concern of Krupp's has announced its withdrawal from the project to amalgamate five of the largest groups in the Rhenish-Westphalian iron and steel industry. The other four groups concerned are the Phoenix, Rheinstahl, Thyssen, and Rhine-Elbe Union. The main objects of the proposed amalgamation were the elimination of unprofitable departments, the rationing of output, and the sharing out of processes among the groups.

Krupp's it is now explained, is unsuited to amalgamation on these lines. Its special position in the heavy industry and the lines of its development are very different from those of the other four groups. It is pointed out that the only concern which occupies a similar position is the Good Hope Works, and that this concern has always held strictly aloof from all amalgamation schemes.

Ever since before the war Krupp's has specialized in certain lines of steel production and refining processes. It has always, for example, concentrated on steel for the construction of automobiles. The firm is apparently unwilling to surrender these special lines. It prefers to work on its own as hitherto, and considers it in the interest of the German heavy industry that the name of Krupp's should not disappear into an amalgamation.

It is declared, however, on behalf of Krupp's, that the concern has no intention whatever of working in any way against the trust if it is formed. On the contrary, it is prepared to co-operate with the trust in a friendly way and particularly by means of special agreements to fall into line with every effort at rationing that may be made, even if it has to make some sacrifice to do so. Should it be considered in the general interests to limit production of any particular articles Krupp's would not, it is stated, remain outside any general arrangement to that end.

There appears to be some doubt as to the future of the amalgamation project, but it is thought that the other four groups will probably continue negotiations.

Cutting Salamanders and Heavy Masses of Iron With an Oxygen Lance

By E. E. THUM*

THE object of this paper is to outline methods whereby large masses or blocks of iron or steel may be cut to handling size. Such "white elephants" arrive from time to time at every furnace plant, and often must be handled with the minimum of delay. Salamanders, furnace bottoms, bad spills, heavy ladle skulls, huge ingots, or big blocks of iron or steel are instances. Many times it is impossible to blast these apart, because of the danger to surrounding structures; often the metal is full of half burned coke or layers of slag, or far too thick for an ordinary oxy-actylene cutting blowpipe. All such masses of metal, clean or dirty, to any thickness yet encountered, can be drilled by an oxygen lance at high speed, or

lb. per sq. in. This must be reduced and controlled for the purpose in hand, and is done by connecting to the discharge end of the manifold a "manifold regulator". It consists of a pressure reducing valve, capable of being set to deliver at given pressures. It is equipped with suitable gauges, showing the pressure in the cylinders and at the discharge side of the regulating device.

For hose, 7-ply oxygen hose, $\frac{1}{4}$ or $\frac{3}{8}$ in. diameter, 50 ft. long, will ordinarily be ample. Avoid armored hose, because if for any reason it should burst, small fragments of the wrapping are thrown about. Plain rubber hose merely opens up. Also avoid pneumatic hose and fittings. It is essential that "oxygen" should



Drilling holes with oxygen in a heavy steam hammer base. Note the guard which is used to protect lancers.

in conjunction with a cutting blowpipe, can be cut across bodily without the aid of explosives.

An Oxygen Lance.

First it would be desirable to describe the lance for the benefit of those who have not seen it in operation.

It consists essentially of a steel pipe, passing a stream of pure oxygen. Obviously a source of supply, and flexible connections are also part of the equipment.

Heavy equipment requires much oxygen. Therefore, five cylinders are ordinarily connected to an appropriate manifold, to assure that failure in gas supply will not occur at an inconvenient time.

Initial pressure in these cylinders is high—2,000

always be sharply distinguished from "air"—several bad accidents have occurred because of this confusion in names. If pneumatic fittings are used, sooner or later some old or oily hose from air hammer or other pneumatic equipment will be connected to an oxygen supply, and a burst or burned hose will result. Remember that oil or grease will burn spontaneously if struck by pure compressed oxygen.

A handle, consisting of a piece of bent 1 in. pipe, is desirable, to enable the operator to stand to one side of the lance. The handle should end in a bushing for the lance pipe.

The size and kind of pipe varies according to the duty. Ordinarily standard $\frac{1}{4}$ in. steel pipe is used. Each length should have a coupling and free running thread so a burned-off pipe may be replaced with the minimum delay. It should also be free of oil and

*The Linde Air Products Company, New York City.

grease—the best way is to place it on a hot steel runner or slag ladle until it gets red hot from end to end. Then blow out the char with clean compressed air.

Operation of the Lance.

The lance penetrates iron or steel by virtue of fact that if this metal is heated to a bright red, it will burn in pure oxygen, generating enough heat to keep the combustion going, and to melt the resulting oxide into a liquid slag. The action is focused at the end of the lance pipe, and consequently a hole can be pierced in any direction, by merely advancing the lance in the right direction. If a layer of slag is encountered, the lance pipe itself burns, furnishing the necessary heat and flux to melt through the slag. Nothing stops it.

Further details of operation can be inferred from figure, and are given when discussing specific jobs, below. However, a general precaution about the use of excessive pressure is in order. Only the most gentle flow of oxygen is necessary to start a hole. For a "match" the end of the lance pipe is heated to redness in a rivet forge or by a welding blowpipe, the helper at the regulator "cracks" the valve (i. e. passes the merest trifle of oxygen through, hardly enough to show pressure on the gauge) and the pipe end burns like a 4th of July sparkler. As the hole gets deeper and deeper, the lancer signals his helper at the regulator for more and more oxygen. "Up" holes, from which molten slag and oxide run by gravity, obviously need less oxygen than "down" holes, where the molten pool at the bottom must be blown up and out by excess gas. And, in general, the higher the pressure at the regulator the bigger and faster the hole drilled. Low pressures allow closer observation and control. But in any event, no more oxygen should be given the line than is necessary for the work in hand.

Drilling Salamanders.

Even the best of furnace will eventually be shut down for rebuilding the brick lining, whereupon large masses of solid iron will often be found accumulated in the bottom of the hearth, below the elevation of the tap hole. These metal masses are found in both blast furnaces and open-hearth furnaces—possibly more extensive in the former, but often a very big, tough chunk of steel and lining underlies the open-hearth bottom. These "salamanders", so called, have apparently grown slowly by the metal bodily replacing the foundation brick. They must be broken up and removed before reconstruction of the furnace can begin. Nearly always this is a "rush" job. It is done by drilling the mass and blasting it into pieces small enough to drag out. Sometimes it may be cut apart by a combination of cutting blowpipe and oxygen lance.

When it has been decided to drill blast holes with an oxygen lance, it is not even necessary to wait for the salamander to get cold. A working scaffold can be built and burning started as soon as the furnace walls are torn down. In fact, it is obviously a distinct advantage to burn into hot metal; the combustion is more rapid, the fire never "blows out", and since there is always hot iron to burn at the bottom of the hole, an iron pipe sheathed in hardwood, or even a copper pipe, can be used for a lance. However, it is advisable to have a rivet forge and a supply of double strength iron pipe handy, in case the hole

strikes a mass of slag or firebrick enclosed in the main mass, when some burning iron will be necessary to provide heat and flux to pierce it.

Drilling by a lance is very rapid. Not more than two minutes' actual burning time is required to sink a hole 2½-in. diameter, one foot deep, into a hard mass of metal. Burning is interrupted three or four times, however, to renew the burned-off pipe, so it may require 5 minutes to sink a hole 1 ft. deep. To do it consumes at the most 45 ft. of ¼-in. pipe and 100 cu. ft. oxygen. (These figures are for piercing the dirtiest cast iron with gas pressures at the regulator as high as 90 lb. per sq. in.)

Masses of metal under the hearth of a blast furnace which are to be broken up by drilling and blasting usually contain so much dirt and spots of hard white iron that it is impracticable to pierce them with a twist drill. Rock drills, run by compressed air, have often been used, but even when the metal is softest it requires about two hours to penetrate one foot of iron. In ninety-nine cases out of a hundred this is too slow for the manager. A comparative estimate of the cost of doing the work by these two methods in a large steel plant is given below.

COMPARATIVE COSTS OF DRILLING DIRTY CAST IRON

Oxygen Lance	Rock Drill
100 cu. ft. oxygen (on the job) .....\$1.40	Power: 60 hp.—hr. at 0.3 ct. ....\$0.20
45 ft. ¼-in. iron pipe at 2½ ct. (less if copper may be used) 1.10	Maintenance of equipment: ¼ day at \$1.00 ..... .25
6 min. labor at \$1.00 per hour ..... .10	Operator and helper: 4 hours at 50 ct. 2.00
Helper at 50 ct. .... .05	Drill steels: 2 lb. at 10 ct. .20
Charcoal and miscellaneous supplies ..... .10	Blacksmith shop expense: sharpening drills 1.00
Total .....\$2.75	Total .....\$3.65
per foot	per foot

While a saving of several hundred dollars in labor and material may be made by drilling a salamander with oxygen, instead of using other methods, it is the saving in time in getting a furnace back into blast which really counts. Whereas 60 days used to be the allowance for major repairs on a blast furnace, this time has now been cut to 45 days. This 15 days may be saved largely by saving the delay required to cool the salamander and to drill it by antiquated methods. Since a modern furnace must earn in the neighborhood of \$1,000 a day in order to meet taxes, fixed charges and interest on investment (totalling to about 15 per cent per annum on \$2,500,000), a 15-day saving is equivalent to \$15,000 losses avoided. To say nothing of profits earned in two weeks' extra operation.

Similar economies are possible in open-hearth repairs. "Oxy-acetylene Tips" for June, 1925 (published by The Linde Air Products Company) contains an account of how a salamander, 12 ft. wide by 20 ft. long, accumulated in a 20-ton steel foundry furnace after a long campaign, was removed in one shift.

Breaking Up Spills and Ladle Skulls.

At rare intervals a bad accident happens to a blast furnace or steel furnace. The heat and slag have eaten into the brickwork thinning it to a dangerous extent, when suddenly the walls give way and the white-hot contents pour over the surrounding floors and into the cellars.

Such breakouts must be cleaned up with speed to get the unit back into production. Large chunks of metal may be drilled with an oxygen lance and blasted—like a salamander. Thinner spills of clean metal may be cut into manageable sizes by a hand-type oxy-acetylene cutting blowpipe. If the metal contains much slag, or is of great thickness (like a recent breakout which filled a 3 x 4 ft. tunnel) and cannot be blasted without danger to the surroundings, the oxygen lance may be used as a cutting blowpipe.

Under certain operating conditions, "ladle skulls" may accumulate in large numbers, too thick to be broken by the usual methods of dropping a ball on them, and represent a considerable tonnage of iron which must be blasted to charging-box size. (These skulls are the shells of pig iron which freeze around the inside of the ladles used to carry molten metal from blast furnaces to steel refining departments.) Such a skull dump can be speedily cleaned up with the aid of an oxygen lance.

Manifolds should be used on such jobs using several cylinders of oxygen daily.

At one steel mill during 1922 several thousand tons of ladle skulls were reclaimed for a total of \$4.00 per ton, including charges for locomotive crane. Figures already given under "Drilling Salamanders" will represent maximum cost of drilling large holes for such work (2½-in. diameter, one foot deep). Often a hole 1 in. in diameter will be all that is needed to hold the dynamite blasting charge. This can be driven with a pressure at the regulator of 40 lb., and a ¼-in. pipe. Such a hole one foot deep can be driven with 20 cu. ft. of oxygen and 12 ft. of ⅛-in. pipe, at a total cost of about 90 cents.

It should be remembered that these costs are for dirty cast iron. Even less will be required for drilling holes into ingots or heavy scrap of clean low-carbon steel, especially if the hole can be driven horizontally or on a slight up grade. Such a hole will clean itself of molten slag and metal by gravity, and the oxygen is used exclusively for the chemical reaction. For small holes pressures can be surprisingly low—starting with 5 lb. at the surface, working up to 35 lb. at 4½ to 5 ft. deep.

Cutting Ingots and Heavy Metal Masses.

If a heavy casting, like a steam hammer anvil, is to be broken up, the cheapest way is to drill a row of holes, load them with dynamite, and discharge them all simultaneously by an electric shot firer. However, an expert powderman may not be available, and the hazard accompanying this method may be judged too great. Some other scheme is necessary for metal too thick for a cutting blowpipe.

Heavy ingots, often must be cropped before being reheated. If they weigh only a few tons this can be done by nicking several inches deep at the required place by a cutting blowpipe and dropping a 10-ton weight on them.

Larger ingots—weighing 25 tons and upward—and heavy masses of cast iron (like a hammer base, or a thick "spill" of metal) may not be broken in this manner, nor blasted apart. They are also too thick for an oxy-acetylene cutting blowpipe. Such bulky pieces of iron or steel however may be cut with a blow pipe and a lance working in conjunction, as shown in the figure.

One operator handles a cutting blowpipe (Oxweld C-6). This cut starts at one corner and is adjusted to make a wide cut 2 to 3 inches into the mass and deliver a steady stream of white hot metal and slag dripping out of the bottom of the cut. After the blowpipe has advanced 2 or 3 inches into the metal, the oxygen lance is brought into play by the second operator, and follows along after the cutting blowpipe. The lance should be ¼-in. pipe (no larger). Oxygen pressure at the regulator varies with the variety of steel—about 25 lb. higher for low carbon or soft steel, than for medium carbon or machinery steel containing up to 0.5 per cent carbon. The volume of oxygen passing out the lance should be carefully regulated so combustion is never "blown cold" by a rush of oxygen, and yet the action not be unduly delayed by a lack of it. A third workman will therefore be required to adjust the pressure regulator and to handle oxygen cylinders and change lance pipes.

It will be found that the stream of oxygen coming from the lance will cut into the metal under the hot slag drip prepared by the cutting blowpipe. The lance then is moved slowly down the face of the cut close behind the advancing incandescent region so produced. On reaching the bottom, the lance is leisurely lifted back up to the starting position and again lowered behind the glowing mass of slag and metal. The motion of the lance is thus seen to be somewhat like a cross cut saw, up and down, each time removing a layer of metal.

At the end it will be found that the cut surfaces are smooth and regular.

Steel can be cut in this manner in masses up to 5 ft. and thicker at the rate of approximately 1,100 sq. in. per hour. (For instance, a cut 30 in. long in a 3 ft. slab, a cut 18 in. long in a 5 ft. slab, or a 36-in. octagon ingot can be cut in one hour). On such work the hourly consumption of supplies will be approximately as follows: Oxygen, 1,250 cu. ft.; acetylene, 35 cu. ft.; ¼-in. pipe, 50 ft. In estimating the cost of reducing extra heavy steel scrap to handling size, it is necessary first to lay out the cuts which are desirable and figure the total area of these cuts when finished. Dividing this total area by 1,100 sq. in. will give the time required to do the job. Obviously the cost per ton will vary widely depending upon the amount of cutting necessary to get the steel to handling size. However, records of nine different clean-ups on good steel, ranging from 3 to 7 ft. thick, show costs ranging from \$2.20 to \$6.30 per ton (averaging \$4.00 per ton) to reduce the material to chunks weighing from 4 to 8 tons.

Chilean Mining Concessions

Senor Adrian de La Cuadra of Santiago and Valparaiso, Chile, representing important Chilean mining properties and concessions, has recently arrived in this country with plans and details of a number of copper, zinc, gold, silver and other mineral properties controlled by him and his associates in Chile. He has signed contracts with Frank Hodson, Consulting Metallurgist, 604 Jefferson Bldg., Philadelphia, Pa., for the exclusive handling of these concessions in this country. Mr. Hodson reports that the properties comprise some of the largest and most valuable ever brought to this country from South America.

Recovery of Furnace Dust, Treatment of Mine and Domestic Waste

Discussion of Various Problems of Increasing Importance

By W. M. VON BERNEWITZ*

MANY machines developed for the reduction and treatment of gold and silver ores have been adapted to other industries. These machines include those that crush and grind, concentrate, separate, settle, thicken, and filter. In the Pittsburgh, Pa., district, are a number of thickeners at work on various pulps, and I was enabled to obtain the following notes as to their operation:

Thickeners for Recovering Iron Blast Furnace Dust.

The cleaning of blast-furnace gas is an economy in that it results in gas clear of dust for boilers, hot-

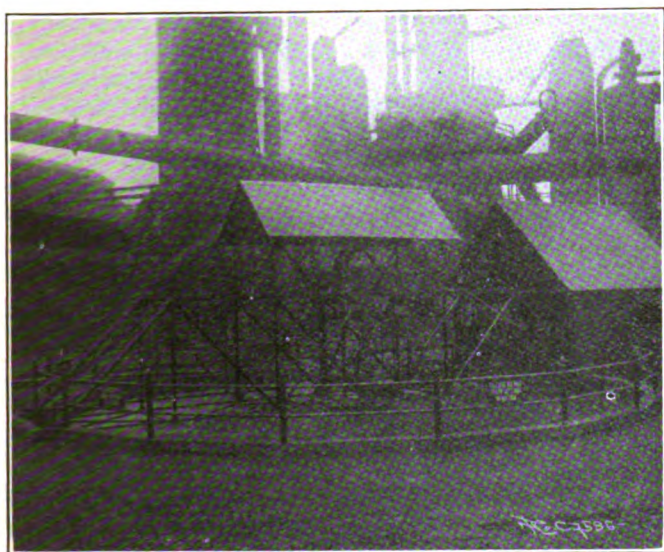


FIG. 1—View of Steinbart gas washers in service at National Tube, McKeesport plant. Blast furnaces and stoves in the background with a thickener in the foreground.

blast stoves, and gas engines, also the dust saved is approximately equal in iron content to that of the ore fed into the furnace.

At McKeesport, Pittsburgh district, the National Tube Company has four 500-ton furnaces in blast. The dust catchers remove a large proportion of the dust, but the gases still carry 3,040 grains of solids per 1,000 cu. ft. say three grains per cu. ft. Part of this gas goes to the boilers and is used without being cleaned and the remainder, which is returned to the hot-blast stoves, is first washed in Steinbart washers. (It may be stated here that each pair of furnaces has a washer and thickening plant, but the notes following refer to the equipment for No. 1 and 2 furnaces and is shown in Fig. 1). Each washer consists of a pair of steel towers 73 ft. high and 12 ft. in diameter. Water from the Monogahela River at a temperature of about 68 deg. F. is pumped to the top of the towers. The temperature of the furnace gas as it enters is 226

deg. F. and the clean or washed gas is 77 deg. F., at the same time the temperature of the wash water is raised to 126 deg. F. The warm pulp from the washers flows through 83 ft. of 10-in. pipe to a Dorr thickener.

The thickener is of concrete, with 15-in. walls and 9-in. bottom. It is 50 ft. in diameter and 11 ft. 4½ in. deep at the center; the bottom has a slope of 1¾ in. per foot to the center. The pulp feeds at the center and the clear water overflows all around the tank and is returned to the river. During an average day the feed amounts to nearly 800,000 gallons carrying 137 grains of solids per gallon, and the overflow 5.3 grains per gallon. Settling is fairly rapid, judging by the rate as seen in a sample of pulp in a baker. The speed of the arm is six revolutions per hour, and a 5-hp. motor drives the gear. A diaphragm pump, which works about four hours a day, draws off the sludge through a 4-in. pipe. This sludge, which carries 44.6 per cent solids and 45 per cent iron, runs into a V-shaped collector, then into a small pressure tank which forces the sludge about 200 ft. through 2-in. pipe and it is merely sprayed onto the dust drawn from the furnace dust catchers. This material is eventually recharged into the blast furnaces.

The solids are thickened to a point where they make an ideal feed for continuous vacuum filters, and this type of equipment is sometimes installed at furnace plants for further dewatering.

During a test of the equipment, the thickener yielded 33,800 lbs. of sludge per day, of which 15,205 lbs., or 7.6 tons, was sludge. As this sludge receives the same treatment as iron ore, its value is calculated as such, therefore, roughly, 7 tons of sludge at \$4.25 per ton is \$30 saved per day from two furnaces, and at small cost for power, labor, and maintenance at the thickener.

Thickeners for Water Treatment.

At a Mine Neutralizing Plant—Many Coal mines produce acid mine water which, without some treatment can not be used at the mine power plants or at coke plants, and may not be discharged into streams. The Calumet mine of the H. C. Frick Coke Company, about 6 miles southeast of Greensburg, Pa., produces 1,100 tons of coal a day from the Pittsburgh bed. The workings are drained by three 8 and 10-in. boreholes which deliver 1,000,000 gal. of water in 24 hours. This water carries 21 grains of free H_2SO_4 per gal. and the following incrusting solids: SiO_2 , 4; $Fe_2O_3 + Al_2O_3$, 26; $FeSO_4$, 6; $Fe_2(SO_4)_3$, 59; $CaSO_4$, 47; and $MgSO_4$, 8, a total of 150 grains per gallon. The suspended matter amounts to 15 grains per gallon.

About 10 years ago the company erected the neutralizing plant shown in Fig. 2, and operated it successfully.

The precipitate, largely Fe_2O_3 , was sold to gas companies for the removal of H_2S from artificial gas,

*U. S. Bureau of Mines, Pittsburgh, Pa.

but the more recent absorption process has affected the market for ferric oxide.

In brief, the neutralizing plant consists of a Fuller-Lehigh pulverizer which grinds limestone to pass 200 mesh; a tank in which the limestone is mixed with raw mine water; a wooden flume with baffles alternately projecting from the top and from the bottom—is in a zinc precipitating box—which further mixes the limestone and mine water and imparts an undulating motion to the current and so aerates the water; a Dorr thickener of wood 70 ft. wide and 7 ft. deep at the periphery and 12 ft. at the center; and a settling and drying plant (rotary drum internally heated and sludge dried on outside) for the ferric oxide sludge.

The thickener is fed at the center, the point of discharge being deep enough to prevent agitation of the upper part of the water. The speed is one revolution in 5 minutes and the capacity of the thickener allows of a settling period of 4 hours. A diaphragm pump draws off the sludge from the thickener. The free H_2SO_4 is reduced to 0.5 grain per gal., a decrease of nearly 98 per cent from that in the raw mine

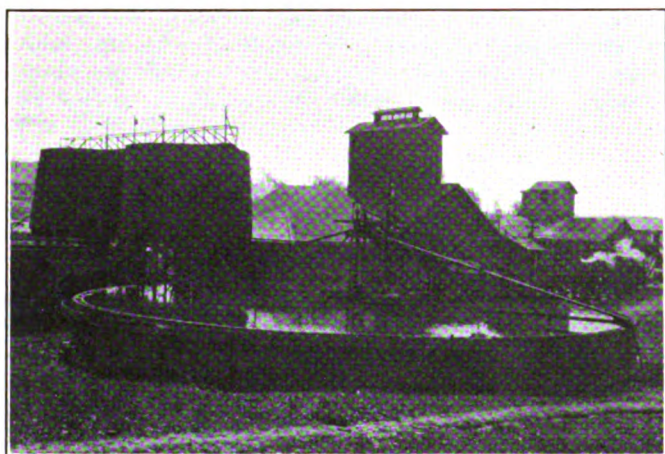


FIG. 2—Neutralizing plant for improvement of mine water at one of the H. C. Frick Company, operations.

water. The incrusting solids are now SiO_2 , 16; $Fe_2O_3 + Al_2O_3$, 57; $FeSO_4$, 9; $Fe_2(SO_4)_3$, none; $CaSO_4$, 131; and $MgSO_4$, 17, a total of 230 grains per gal. The suspended matter, 41.3 per cent Fe_2O_3 , amounts to 100 grains per gallon.

At a Water Softening Plant.

In what is known as the South Hills district of Pittsburgh, the South Pittsburgh Water Company, supplies a population of about 180,000 people. Water is taken from the Monongahela River, where it is neutralized and then pumped through two 24-in. cast-iron pipes to the softening plant two miles distant. Here, after aeration for removal of CO_2 , a solution of lime and soda ash is added continuously to the water in four 30 by 20-ft. mechanical agitators. The overflow from these passes into a Dorr thickener, shown in Fig. 3.

This thickener is 80 by 20 ft., and has a maximum capacity with this water of 20,000,000 gal. per day. The present demand from the Water Company is about 12,000,000 gals. daily. The condition of the river water determines how much water is to be treated at the softening plant. At present 11,000,000

gals. pass through the thickener; the remainder is by-passed to the filtration plant where it is mixed with the softened water and all is filtered together and has the correct hardness. A well-equipped laboratory is maintained and many samples here and along the river are run each day. The thickener moves at one

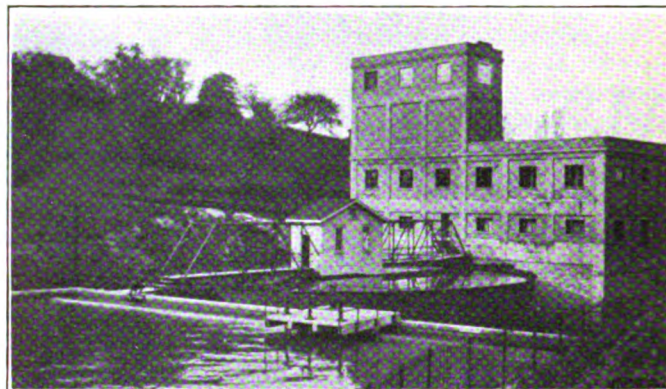


FIG. 3—Softening and clarifying and thickening plant, with storage basin at South Pittsburgh Water Works.

revolution in 20 minutes and is fed at one side with a baffle extending down about 6 ft. The purpose of the thickener is to clarify, by settling and thickening, the precipitate produced by the lime-soda ash treatment. This it does well, as little flocculent material overflows into the 5,000,000-gal. storage basin. The precipitate, or sludge, from the thickener flows by gravity in a continuous $\frac{1}{2}$ -in. stream and amounts to 40,000 gals. per day, and consists of 10 to 15 per cent of solids ($CaCO_3$, Mg, Fe, and $Al(OH)_3$). The softened water from the storage basin flows to the filtration plant mentioned, and there passes through sand filters which are cleaned by reversing the flow once a day.

Acknowledgement.

I am indebted to the officials of the National Tube Company, H. C. Frick Coke Company, and South Pittsburgh Water Company for their willingness to allow me to see the equipment described.

Effect of Phosphorus on Swedish Iron Ores

By A. C. Blackall

In an address recently delivered before the Iron and Steel Institute in London, Dr. H. von Eckerman showed that a considerable reduction of the phosphorus content of charcoal derived from Swedish fir and spruce forests is obtainable by cutting the right parts of the trees at the right season and floating the logs down the rivers to the carbonizing plants. Further, he pointed out that by lowering the amount of phosphorus in the charcoal the range of Swedish ores available for the production of high-grade pig iron may be extended as well as the quality raised.

In the old days the Sheffield crucible works hardly ever asked for analyses of Swedish rough bar. They kept to certain brands manufactured from certain ores, and were satisfied if the resulting steel showed the high quality required. Today chemists are evaluating the quality of an iron by computing the analyzed quantities of sulphur, phosphorus, oxygen, nitrogen, hydrogen, etc., present, and, even if sometimes disagreeing with their standards of value, the Swedish iron works have certainly tried to meet their demands.

Electrical Applications, Progress, Trend

The Influence of Super-power Discussions Is Beginning to Manifest Itself Through Interchange of Power

By GORDON FOX*

THE continued growth in size of many steel plants, together with the general adoption of electric drive for main roll trains, has brought about increases in capacity of steel mill power plants, making them comparable with those of the public utilities. The generation of power in the steel mill is now concentrated in one or more stations most favorably situated from a power generation standpoint. Blast furnace gas is being burned more completely and more efficiently. Coke breeze is being fully utilized and the current year has seen a more general realization of the value of waste heat from the open hearth furnace. The use of new fuel at the power house is being minimized, but the methods of firing such auxiliary fuel are being given much consideration.

Some of the economies of interconnection which accrue to the combination of public utilities have been adopted or are being studied by the steel plants. Progress is being made toward more complete interconnection of mill power plants. The public utilities are realizing more fully the steel mill viewpoint and are offering plans for the use and interchange of power which are adaptable to the mill policy of utilization of by-product fuels and waste heat.

The greater concentration of power in steel mill power plants together with the increases in capacity of public utility systems to which the mills may be connected is forcing the use of suitable high capacity switching equipment. The realization of the greater responsibility resting in the electrical system is leading to more elaborate switching, transmission and protective systems. The costs incident to this necessary protection are a function of the growth of the system. These costs are mounting.

The field of main roll drives is still undergoing numerous changes and rapid development. Two reversing motors for blooming mills have been installed, rated at 7,000 hp. and built with single armatures. Previously motors of this capacity were provided with two armatures on a common shaft.

In the field of non-reversing mills adjustable speed is more frequently demanded. Adjustable speed alternating current drives have seen some development. A Kramer set of 7,500 hp. capacity operating between 134 and 250 rpm. was installed by the Youngstown Sheet & Tube Company for a 21-in. continuous sheet bar and skelp mill. This set is the largest of its type yet constructed.

A Scherbius drive built for the Trumbull Steel Company's 16-in. hot strip mill is novel in that two auxiliary speed-regulating machines are provided. The main motor is rated 5000/4000/3000 hp. at 450/360/270 rpm. Each regulating set is rated at 480 kva. at 514 rpm. Synchronous motors are used in the regulating sets. To obtain the full speed range, both regulating sets are required, each having half the required capacity. In case either regulating set becomes disabled,

the remaining unit can be made to function, giving one-half the rated speed range both above and below synchronous speed.

A reversion to direct current motors for main roll drives is in evidence. For the smaller mills, where adjustable speed is desired, the direct current motor with conversion equipment compares favorably with the alternating current speed set and it is being favorably received.

The further subdivision or individualizing of main roll drives continues, particularly in multiple drives for mills in tandem. Speed adjustment and speed regulation, characteristics of direct current motors, have led to their adoption for these drives which require close synchronizing of mills. The drive for the new 20-in. 16-in. hot strip mill of the West Leechburg Steel Company exemplifies this practice. Six roughing stands are driven by one 1500-hp. 720-rpm. induction motor. Two intermediate stands are similarly driven. The four finishing stands are individually driven. The first two are each driven by a 1500-hp. 125/250-rpm., 240-volt, d.c. compound wound adjustable speed motor. The last two stands are each equipped with an 1800-hp., 165/350-rpm. motor of similar type. As the steel may be in all four finishing passes simultaneously, correct relative speeds of the individual stands must be closely maintained.

The use of synchronous motors for constant speed main roll drives is making headway. The installation of a 9,000-hp., 107-rpm., 6600-volt, 25-cycle synchronous motor at the plant of the McKinney Steel Company at Cleveland marks a decided step forward. This motor has a double shaft extension and is coupled to a long lay shaft from which are driven 10 stands of a continuous billet mill. The synchronous motor is being selected more frequently for driving pumps, fans and similar accessories wherever it will fit, due primarily to power factor considerations.

Although some low speed motors for direct connection to mills are being purchased, the trend favors the high-speed motor with gear drive wherever this type of drive can be fully justified by first cost and economy considerations. A notable contribution to the literature on this subject was made by Mr. E. A. Hurme. This appears in the May, 1925, issue of the *Iron and Steel Engineer*.

Much interest has been aroused by a departure in armature windings for direct current motors known as the frog-leg winding. This winding eliminates the usual equalizer connections and tends to improve the commutating qualities. Two 1500-hp., 150/300-rpm. motors built for the Bethlehem Steel Company were recently subjected to severe tests before a number of electrical engineers of the industry to demonstrate the efficacy of this new development.

The auxiliary mill drives are coming in for more careful consideration, and it is recognized, in some quarters at least, that the proper analysis of the requirements of these manipulating movements pro-

*Electrical Engineer, Freyn Engineering Company, Chicago, Ill.

duces worth while results both in better performance and reduced maintenance charges. Two noteworthy contributions on this subject have been made, one by Mr. F. D. Egan, "An Analysis of a 40-in. Blooming Mill Screw Down," the other by Mr. W. W. Garrett, "Auxiliary Motor Control." Both of these were published in the Iron and Steel Engineer.

Magnetic control is increasing in popularity and is gradually gaining predominance over direct manual control. The time element basis of acceleration is finding much favor and several types of control have been recently brought out offering this characteristic. A number of electrical engineers in the steel mills now favor the use of primary resistance for starting squirrel cage induction motors. A new type of starter for squirrel cage motors using primary reactance has been placed on the market during the year.

The need of proper protection for control panels is better recognized. Some of the notable installations of the year have placed magnetic control equipment in the substation or motor house or have provided other substantial and tight enclosures. The need of accessibility to enclosed magnetic starters is becoming evident and one manufacturer has met this need with a hinged panel which swings forward much like the panel board in our radio sets.

Having earned a foremost place as a means of power transmission and power application, electricity is making inroads into the field of heat application.

The installation of an electrically heated soaking pit at the plant of the Donner Steel Company has been watched with much interest. Even in this service, ordinarily viewed as a bulk heating job, electric heat has much to offer. Both the number and the variety of electric furnaces in use for annealing and heat treating duty are increasing. Particular interest is shown in the electrically heated sheet annealing furnace. The electric heater for hot mill rolls is gradually earning recognition as a necessary adjunct to the efficient sheet or tin mill.

Relation of Carbon Consumption to Material Smelted in the Blast Furnace

(Continued from page 15)

tion. It was noticed that there is a fixed relation between the amount of carbon consumed and the amount of material smelted. As the ash in the coke increased the production of iron decreased, but the weight (pounds) of material smelted per pound of carbon remained practically constant. The table following gives operating data covering a period of 10 months. The table shows the tonnage of iron produced, the coke consumption, and the pounds of fixed carbon consumed per pound of material smelted.

It will be seen in item 9 that the value is constant and is not dependent upon the ash content of the coke. According to the above calculations an average of 2.67 pounds of material was smelted per pound of carbon consumed. The variation from the mean was found to be 5.4 per cent, which is within the limits of accuracy of measurement.

Check Test.

Six months later it was thought desirable to check the above results. During this period, coke of the following analysis was used: Fixed carbon, 77.0 per

cent; volatile matter, 1.0 per cent; ash, 21.0 per cent; and sulphur, 0.90 per cent.

It was found that 642,444 pounds of carbon was consumed in smelting 1,682,556 pounds of material, equivalent to 2.64 pounds of carbon per pound of raw material smelted.

Another furnace in the Southern district, observed over a short period, indicated that 2.68 pounds of charge was smelted per pound of carbon consumed; two furnaces operating in Ohio for one month indicated a carbon consumption of one pound for each 2.84 pounds of material smelted; and a furnace in Kentucky smelted 3.00 pounds of material per pound of carbon. Results calculated from unpublished data collected by Royster and Joseph of the Bureau of Mines from 37 furnaces in the Northern district show an average of 2.92 pounds of material smelted per pound of carbon consumed.

American and British Practice Compared.

Evans† has compared American and British practice, using data from 14 American furnaces reported by Royster, Joseph, and Kinney§ and comparing data from one British furnace and a group of three other British furnaces operated by different firms. A comparison of the 14 American furnaces and a group of 37 American furnaces with the single British furnace and the group of three furnaces on the basis of material smelted per pound of carbon gives the following results:

Furnaces	Pounds of Material Smelted per pound of Carbon
14 American (Northern practice)...	2.96*
37 American (Northern practice)...	2.92
1 American (Southern practice)...	2.66
3 British	2.62
1 British	2.57

*Included with the 37 American furnaces.

In comparing the two practices Evans states that the ore used by the British contains less iron and in America more scrap is used, that the sulphur in the coke is higher, and that the silicon in the average American iron is lower. He also states that the sulphur in the British iron is lower. Evans' data on British furnaces leads the writer to believe that this practice represents operation which is somewhat similar to our Southern practice. This belief is substantiated by the comparison by means of values for material smelted per pound of carbon.

The calculated value, pounds of material smelted per pound of carbon consumed, is of value in making practical comparisons between different furnaces operating in a group or on furnaces using entirely different materials and methods. It is of value in checking the performance of any furnace operating from day to day on any group of ores. The effect on carbon consumption with changing ore burdens may also be determined. The value may also be used in studying the economies in connection with use of high and low ash cokes. But it is obvious that the use of the value is limited. It will be slightly affected by differences in heat loss between furnaces, and in cases where extremely low-grade ores are used or where a furnace is used as a cupola.

†Evans, E. C., Fuel in the Iron and Steel Industry, Iron and Coal Trades Review, vol. 61, August 21, 1925, pp. 281-284.

§Royster, P. H., Joseph, T. L., and Kinney, S. P., Heat Balance of Bureau of Mines Experimental Blast Furnace, Blast Furnace and Steel Plant, vol. 12, 1924, pp. 200-204.

SHEET AND TIN PLATE

Genuine Open-Hearth Iron

Andrews Steel and Newport Rolling Mills Form an Unusual Group
Differing in Many Particulars from the Usual Steel Plant

By F. J. CROLIUS

THE Andrews Steel Company and associated companies form an interesting study. In this year 1926, which marks the turn of the first quarter century of the United States Steel Corporation's existence, and at a time when the air is filled with talk of combinations of plants and companies great and greater, at a time when mere size, per se, seems so dominant and impersonal, it is a pleasure to find that success in the steel industry can still be won on a very close approach to the personal basis.

The Andrews family founded the present business, and as a family they have never lost pride in the close daily contact with the men and their organization.

The story of the growth of this unique organization forms a chapter worth remembering. It is a story of ideals adhered to and rewarded.

In 1885, two brothers J. A. and H. L. Andrews organized the Globe Iron Roofing & Corrugating Co., in Cincinnati, Ohio. Buying outside supplies of sheets,

the two brothers produced Corrugated Sheets, Conductor Pipe Ridge Roll, Guttering and many of the various forms used by the general sheet metal contractor.

Five years later, in 1890, they purchased the defunct Swiss Iron & Steel Company rolling mill in Newport, Ky., immediately across the Ohio River. This plant became the nucleus of the present Newport Rolling Mill Company, expanded, modernized and reorganized.

Today this group of plants is the largest single industry in the State of Kentucky, with a monthly production of finished sheets, exceeding 12,000 tons, and supplying markets penetrating even to Japan, Argentine, Venezuela, Brazil and the West Indies.

The building of the Andrews Steel Company plant in 1908 was a direct consequence of this natural trade expansion. A constant supply of uniform sheet bar was the only method which could offer a guarantee of quality and delivery to a wide flung clientele of

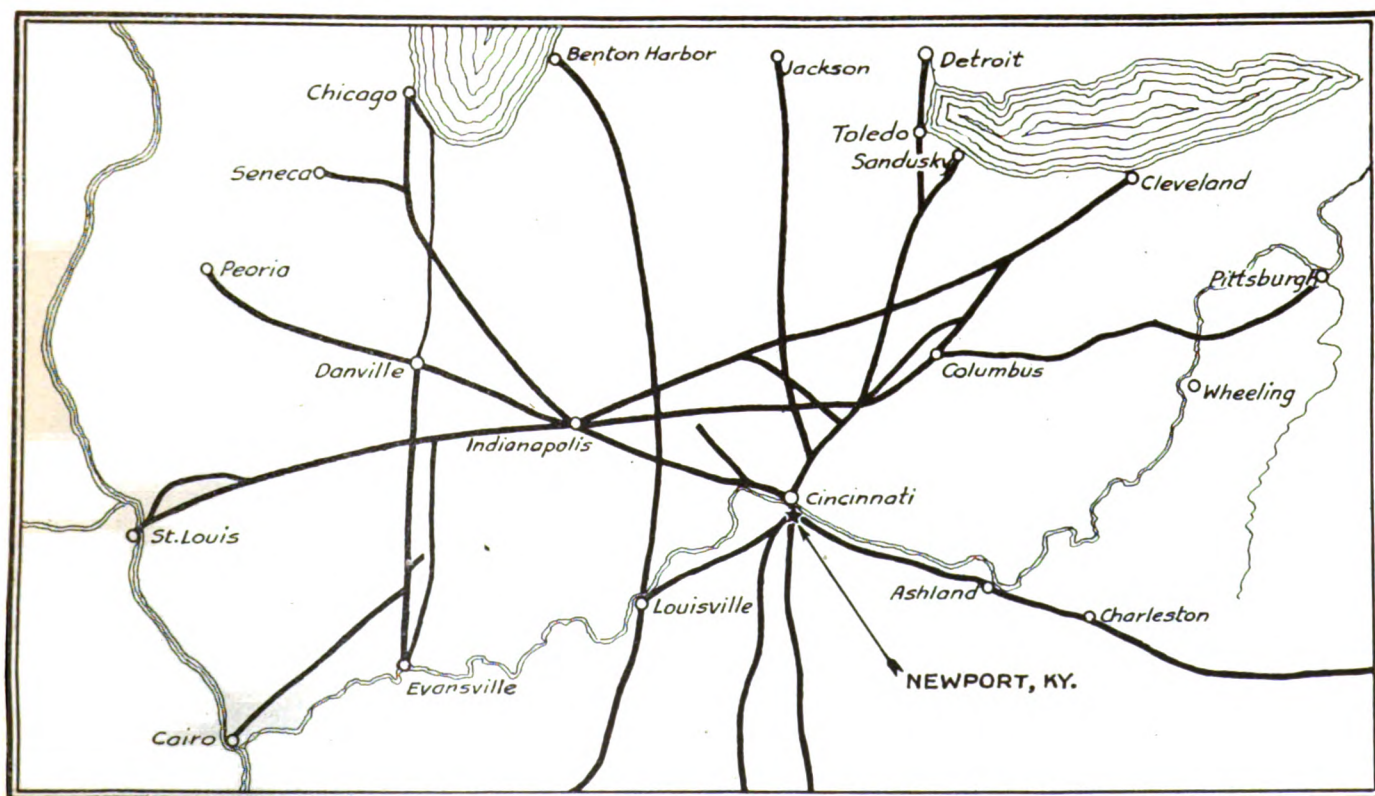


FIG. 1—Map constructed to show the geographical relation of Cincinnati area to the centre of population. A number of the important railroad lines are indicated

sheet buyers. As an adjunct and balance to their mill operations, a new product was developed in the form of special forging billets for oil field tool makers. In 1910, came the addition of the Newport Culvert Company, taking advantage of certain unusual qualities present in Gohi metal, as their Genuine Open Hearth Iron is conveniently called. This sub-company is already the largest individual company in the United States manufacturing Corrugated Metal Culverts.

The physical aspect of their plants, and their strategic location is also interesting, particularly in a group plant of this size and character. The group is not a complete vertical unit, that is, it draws its supply of iron from outside sources, and therefore has no blastfurnace, and needs no by-product oven plant to supply coke. It follows naturally that it is not a heat balance plant, as there are no waste gases, except the open hearth to be relied upon for heating and power purposes. Naturally, also, the open hearth practice favors the higher scrap percentages rather than higher iron, which the absence of hot metal dictates.

Location within the area of greater Cincinnati is, however, nearly ideal, both from a raw material basis, and from a distributing basis. The plant is located on the Licking River, tributary to the Ohio and about a mile from it—with sufficiently deep water to insure Ohio barge shipments of raw materials inward, or finished product outward.

The map shown in Fig. 1 indicates these relations, and the accessibility of this area to either northern iron by river, or Alabama iron by rail.

A recent survey* of the industrial possibilities of the Cincinnati area, made by the Technical Advisory Corporation, contains among its 1,800 pages these significant paragraphs:

Cincinnati's Trade Zone.

Where is Cincinnati's future great trade territory? Largely in the South. The Cincinnati zone of influence, on a basis of freight rates and other vital considerations, includes parts of the following states,

*We are indebted to W. C. Culkins, Executive vice-president of the Cincinnati Chamber of Commerce for this information.

the figures showing the percentage of population of the state within the Cincinnati zone:

Ohio	45. per cent
Indiana	75. per cent
Kentucky	93.5 per cent
Illinois	3.9 per cent
Tennessee	73.5 per cent
Alabama	81.6 per cent
Georgia	70.3 per cent
North Carolina	21.2 per cent
South Carolina	47. per cent
West Virginia	41. per cent
Virginia	7.9 per cent
Mississippi	12.3 per cent

Advantages and Handicaps.

Cincinnati is nearest to the center of population and manufacture in the United States. Few large cities are further South. Most basic raw materials are in this water shed. Cincinnati is on the greatest system of inland waterways in the world, with more fully developed front lines than any territory of similar characteristics. "The city's location could not be improved upon, if one had power to pick it up and replace it." Half the population of the country is within 500 miles. Cincinnati's hills are a disadvantage for industrial operations but provide unusual beauty. There is not another city of its size where so large a proportion of the population can live at so high an elevation above sea level. The smoke from soft coal and the occasional periods of hot summer weather, have been criticized but climatic conditions are generally advantageous.

Cincinnati spends its money at home. The total consumption of the city annually is \$543,000,000. Of this \$155,000,000 worth is produced outside and the rest within the Cincinnati zone of influence. Forests are one of the biggest assets of this region. The bulk of hardwoods are in the Alleghenys. There is a large yellow pine and Douglas fir supply. Nearly half of the total supply is in the reach of Cincinnati. The city may become an important distributing point for Pacific Coast lumber by way of Panama, Mississippi and Ohio Rivers. Cincinnati has two independent sources of natural gas, coal in every direction and satisfactory water supply. The sulphur in Louisiana, zinc in Tennessee and the coal by-products for use

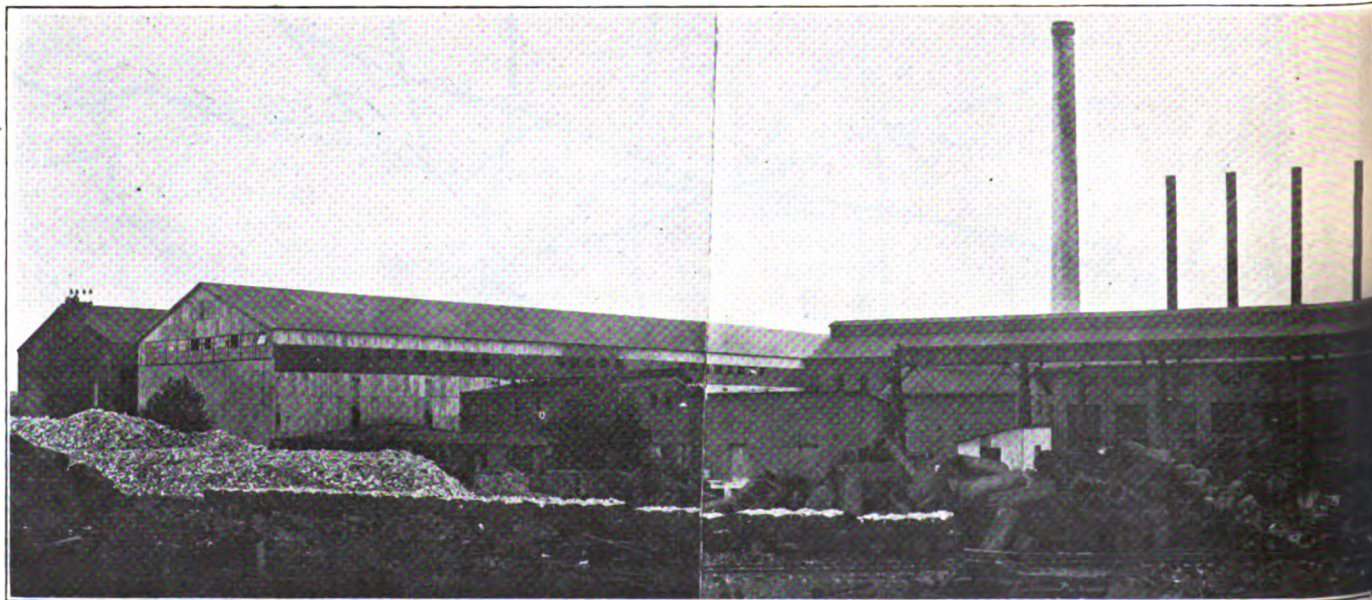


FIG. 2—A panorama of the open hearth plant, heavy rolling mills, power house taken from the railroad side.

of chemical industries, are all at Cincinnati's command. The City's present industries are well diversified.

There is a low annual yield of products per employee at Cincinnati. Employment of women is subnormal. Strict child labor law works to disadvantage in competing with some other states. Some plants are admirable examples of progressive development in industrial relations. The horse power per wage earner is low compared with other cities. Horse power is usually regarded as an index to efficiency. The net margins and gross profit are comparatively high.

Measured by number of daily trains Cincinnati has unequalled passenger service.

Rolling Mill and Steel Plant Equipment.

These plants are essentially coal-fired plants, and advantage is taken of Kentucky's supply of exceptional metallurgical fuel. All the coal for the company's mill operation, besides a surplus for domestic distribution, is drawn from the company's mines and mining community. This Hardburly, Ky., mine is reached by rail approximately 200 miles toward the east.

It is unusual to be blessed with coal from a single mining operation which can be conveniently used for all mill operations, and which can be relied upon to give satisfactory and economic results when fired in gas-producers for the open hearth, in pulverized form on sheet and pair, and annealing furnaces, and also is suitable in the finer screenings for steam purposes on stokers. Analysis is as follows: Vol. 34.74, F. Carb. 59.26, Ash 6., Sul. .65, Btu. 14,120.

About 1,000 tons per day enter the plant, and is consumed as mentioned. The pulverized fuel layout is a notable one, and will be discussed in detail in connection with the sheet mill description.

Andrews Steel Plant.

This department is the steel making and heavy rolling division of the group.

There are eight basic open hearth furnaces, 3-65-ton, 3-85-ton and 2-100-ton. All are natural draft furnaces, except No. 7, one of the 100-ton furnaces

which is of Loftus design, similar to one described in this journal in 1924 January.

This group of eight furnaces averages close to 800 tons of Genuine Open Hearth Iron per day.

Producer-gas is used exclusively in the open hearth furnaces.

There are 27 gas-producers arranged parallel to the open hearth furnaces. Among these producers are represented several types; the original Duff and Bradley's hand poked are still in service, with more recent additions of Chapman mechanical units and larger Morgan producers. The added mechanical features have resulted in a greatly improved quality of gas and increased capacity per unit operated. Coal reaches the producer by broad gauge railroad, and is unloaded, prepared and distributed by a Jeffries coal handling installation.

The layout of the open hearth section is slightly limited in its area for stock yards, producers, and for any further expansion at this point; the Louisville and Nashville bounds it on one side, and the Licking River on the other. Within the space, however, are located parallel to the main open hearth mill stock yards for iron, scrap, etc., and tracks for stripping operations.

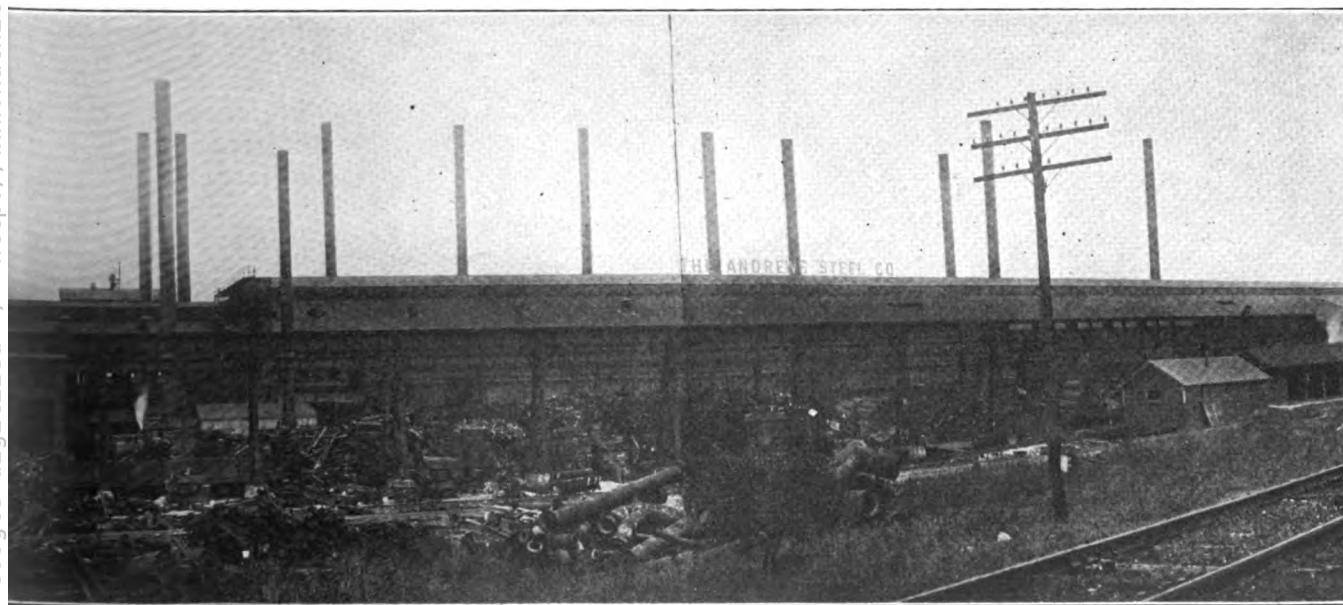
The main stock yard cranes serve as stripping cranes, working over two narrow gauge ingot buggy tracks. Both of these larger cranes, one 100-ton and the other 150-ton are standard Alliance cranes, and the two charging machines are of similar make. Seventeen cranes in all serve this steel making group, including the two Alliance open hearth charging machines.

Heavy Rolling Mills.

Ingots are broken down in a 34-in. blooming mill. Shown in Fig. 4. This is a mill of United Engineering design and installation. A recent improvement to the blooming is the United Manipulator—also shown in three views of this mill.

In the foreground of Fig. 4 can be seen the overhead control room from which point of clear vision the manipulator is operated.

The secondary mill is a three-high Slick bar and billet mill also of United Engineering manufacture and installation.



Raw material shown stocked in the foreground.

About 60 per cent of the capacity of this mill is rolled to sheet bar, and the balance forging billets. Both of these mills are steam driven by Mesta 46-in. x 60-in. engines—which exhaust to mixed pressure turbines.

Steam at 175 lbs. is produced in a coal fired boiler house. There are ten 375 hp. Stirling boilers, equipped with Jones Lateral Retort stokers—and two recently added 1,000 hp. Connolly boilers, equipped with Westinghouse underfeed stokers.

Baily meters are used on each boiler. Copes feed water regulators, damper regulators, Bristol gauges, etc. Wilson-Snyder reciprocating boiler-feeders are installed, also Wilson-Snyder pressure pumps on the hydraulic system.

All boiler water is purified through a Scaife We-guo system.

Compressed air to the shipping yard and mill is supplied by three Laidlaw-Dunn-Gordon compressors. **Power Plant.**

The main power house for the entire group of mills is located at the mill end of the steel plant. Mixed pressure turbines receive the exhaust from both main mill engines.

Main Power Plant.

Two 3,750-kva. turbo-generator units generating 6,600 volt, 3-phase, 60-cycle power—running at 3,600 rpm. The turbos are supplied with jet condensers and heat balance valve. Excitation is furnished by a 25-kw. generator driven by a geared turbine. There is also a 25-kw. motor driven exciter.

Two 500-kw. converters for supplying d.c. power with three 183-kva. transformers for stepping down from 6,600-volt to the necessary a.c. voltage to give 250 volts d.c. on converter.

Newport Rolling Mill Group.

This organization operates the entire sheet mill division.

There are 20 sheet mills driven by two separate motors through Falk reduction gears, the annual capacity totaling nearly 200,000 tons.

Eight cold-roll mills complete the mill layout.

Sheet Mill Drive,

Two 1,800-hp. pedestal type wound rotor induction motor—rated 6,600 volt, 3-phase, 60 cycle, 270 rpm., 26-pole. These motors are supplied with enclosing covers for forced ventilation. The blowers for supplying this air are each driven by a 25-hp. 440-volt, 860-rpm., 3-phase, 60-cycle, wound rotor induction motor. These blowers were supplied by the American Blower Company and are of the Sirocco type delivering 18,000 cu. ft. of air per minute at 2-oz. pressure.

The sheet mills are driven by the two above motors through Falk gear units, the 270-rpm. speed of the motors being reduced to 30-rpm. on the mill. The flywheels for these drives are mounted on the pinion shaft of the gear unit. Flexible couplings are used between the motor and gear unit and between the gear unit and mill.

The control for the 1,800 hp. motors consist of a forward and reverse oil circuit breaker and the motors

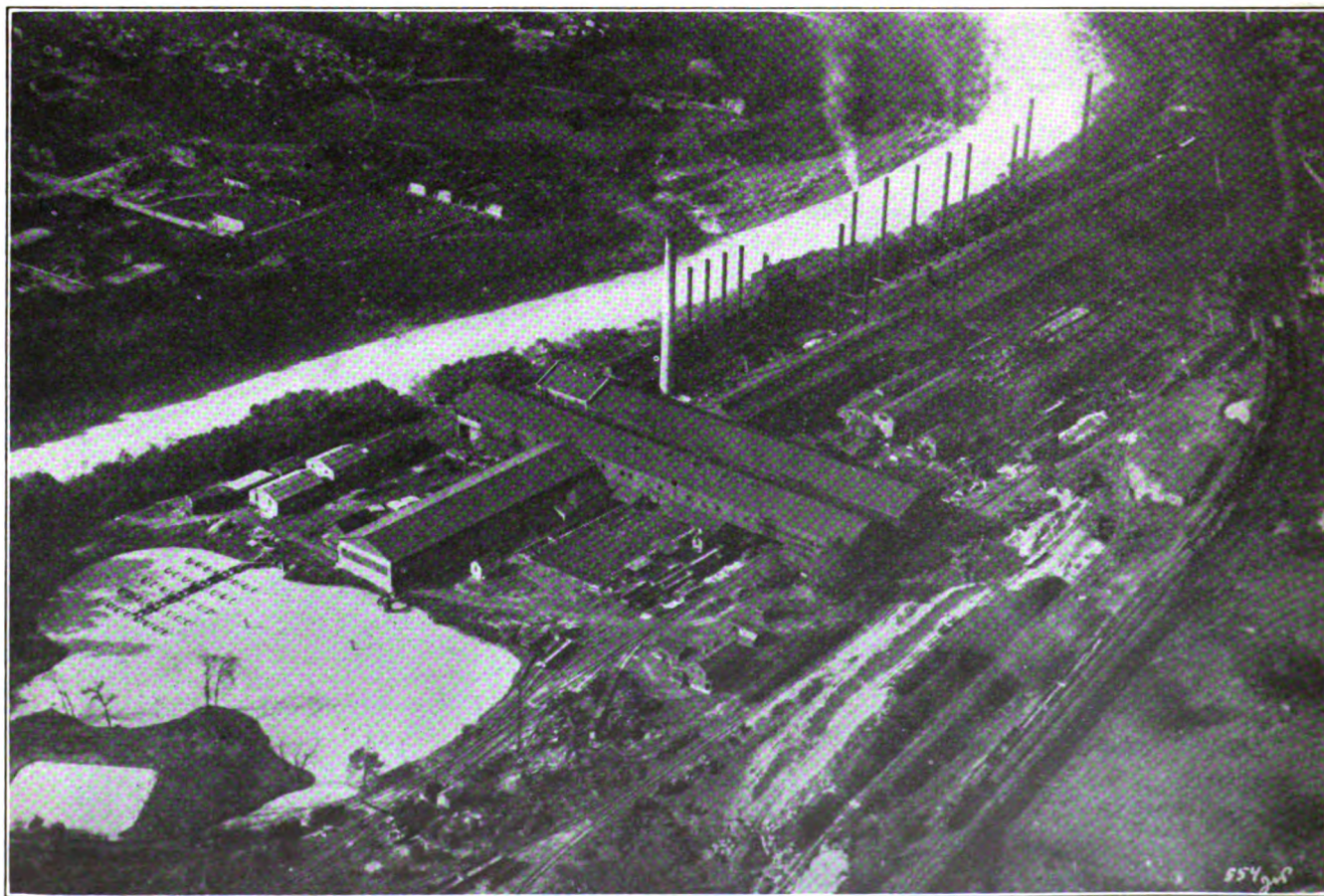


FIG 3—Remarkable birdseye view of Andrews Steel Mills taken from an aeroplane. The Licking River flows in the background, and in the right foreground can be seen the raw material stock yards.

may be plugged. This plugging is used in case it is required to stop the motor in an emergency.

By supplying the motors with forced ventilation the motor is supplied with clean air instead of pulling in

the dust laden air of the mill and thus prevents damaging the windings. Sheet mill motors which do not have forced ventilation collect the mill dust on the windings and in the ventilating ducts and in time cause overheating and sometimes damage to the coils. The ventilating air is brought in at the bottom of the enclosing cover and circulates through the winding and out at the openings in the frame.

The secondary control for each motor consists of a liquid slip regulator which allows the motor to make use of the flywheel. The liquid slip regulator is the best known means of reducing peak loads on a system and of utilizing flywheel effect.

All electric equipment is Westinghouse.

Product.

The sub-division of finished sheets is about equally divided between black and galvanized, and of the galvanized product about 25 per cent is shipped in the finished form of culvert and similar material.

Heating and Annealing Furnaces.

In general, the heating and annealing furnaces are all powdered coal fired. The George J. Hagan Company furnished designs, including the arrangement and complete detail drawings, together with certain special equipment such as pair furnace hearths and pair furnace chargers. There are two types of pair furnaces; one for heating bars for sheet mills which are six groove furnaces and the other for heating bars for tin mills, which are four groove furnaces. The pair furnaces for heating bars for sheet mill were erected as separate units from the sheet furnaces.

The pair furnaces for the tin mill are built-in battery.

On all furnaces, special fire boxes were provided for burning the powdered coal, but these were so arranged that in case it was considered desirable at any later date, that stokers should be applied without extensive alterations.

The sheet and pair furnaces are provided with overhead stacks extending up through the furnace building roof. The annealing furnace both of the box type and the open annealed are provided with stacks located on floor level. These stacks are connected to the furnaces by means of underground flues, with proper damper control.

Aetna automatic doublers are positioned between the furnaces and the mills, as shown in Fig. 5.

One continuous Costello sheet annealing furnace handles the output of annealed sheets. This furnace, also fired with pulverized coal, is of size and capacity adequate for the largest sheets and for record tonnages, such as that recorded in November, when General Superintendent Davis announced that a world's record for 17 mills had been made with an average daily output of 10.61 tons per mill, per turn.

Except on the tin-pot furnaces pulverized coal is fired throughout the sheet mill division.

Nearly 6,000 tons of pulverized coal is fired monthly in the sheet mill furnaces.

Pulverized Fuel Installation.

One of the earliest large installations of pulverized fuel equipment designed to meet the difficult conditions found in sheet mill practice was made at this plant of the Newport Rolling Mill Company.



FIG. 4—Three views of the 34-in. blooming mills, showing the operation of the new United Engineering manipulator, with ingot on its way through the mill. The capacity of this bloomer has been greatly increased by the installation of this special device. The manipulator control room is located in the overhead structure, one corner of which is shown in the left foreground in the top view.

Many similar installations have been made, but this plant is unique in that it has weathered the storm of experimentation and change which has accompanied the development of this special fuel. The original system, with of course many incidental changes, is still in full operation.

An analysis of the system as originally made is still descriptive.

The preparation of powdered coal does not materially differ in the various installations, as there are really only two basic methods of preparing and feeding to the furnaces.

An installation of powdered coal may be divided into the following divisions or parts:

In the case of the direct-fired there is more danger of fire than in the two-pass type.

In this way the heat from the very hot gasses is transmitted through the inner shell by radiation to the coal and the cooler gasses only come in direct contact with the drying coal.

All the gasses are drawn through the dryer by means of an exhaust fan placed conveniently to the furnace end of dryer shell.

These gasses with any particles of coal or ash carried along are driven by the exhauster up into a dust collector, from where they fall into a conveyor which feeds them either into the drying coal elevator or back into the dryer itself.



FIG. 5—A comprehensive general view of the sheet mill stands, with roll storage in foreground. The cold roll mills do not appear in this view, as they are located beyond the second group of hot mills at the far end of this building. The Aetna doublers and the shears are also obscured.

- 1—Crushing, drying and pulverizing.
- 2—Screening or separating.
- 3—Transporting and distributing.
- 4—Feeding and burning at furnaces.

Crushing, Drying and Pulverizing.

1—(a) The crushing is done in the usual way, so that all coal going to dryer will be less than 1 in. in size, of course, where slack is used no crusher is necessary.

(b) The drying is done by feeding the coal regularly through a rotary dryer either of the two-pass or direct-fired type, common to the cement industry.

There are other types of dryers, but generally speaking, the operation is similar.

One of the important items in connection with the dryer is to be sure and not run same too hot, in fact, the temperature at center of discharge end should only be 380 to 420 deg. F.

As the coal dries it is automatically fed along through the dryer, owing to the shell being placed in an incline, and discharges into a basket elevator which delivers the dried coal into a small closed tank placed conveniently over the feed mechanism of the pulverizer, so that the coal comes to the pulverizer feeder by gravity.

It is generally conceded to be good practice not to have the capacity of dried coal bin greater than the rated capacity per hour of pulverizer. This is done to prevent collection of moisture and to eliminate danger of fire due to large body of hot coal too long stationary.

During temporary shut-downs and over night when not operating pulverizer, this dryer and the dried coal bin as well as the elevator should be left empty.

Screening and Separating.

The system employed here and which can be recommended is called the "Air Separation".

This means that the coal fed into the pulverizer is not removed until it reaches the proper fineness, that is, the fineness by weight of particles, as the exhaust fan is adjusted to the speed that will give the proper suction to lift only those particles that are properly pulverized.

Any foreign substance and much of the slate, find



FIG. 6—Five views taken at various points in the pulverized fuel system. Upper left, shows aisle between Raymond pulverizers, with blow-tanks in the rear. Upper right, furnace end of drier. Centre, pulverizers and overhead storage bins. Lower left, outside view of building housing pulverizing equipment, showing coal cars on supply track. Lower right, one of the mains in distributing system.

In some installations the dryer is placed high enough so that the dried coal is fed to the dried coal bin by a screw conveyor instead of a bucket elevator, but this is only a matter of convenience and has very little to do with the operation of the system.

(c) Pulverizing is done in any one of several different types of pulverizers, although we have at this plant Raymond five-roller mills which give very good results, in fact, from a practical viewpoint, may be considered the best mills on the market today.

The Raymond mill has the crushing rolls suspended from a driving frame in a perpendicular position and the rollers, as well as the grinding ring are easily removable for replacement.

sulphur, iron and sulphur pyrites, clay that get in the mill will not be lifted, as these substances do not as a rule pulverize as fine in weight as the coal, and as a result are heavier than the coal particles.

In the air separation mill these foreign substances remain in the bottom and are removed at each shut down, say twice in 24 hours.

In the air separation the exhaustor removes the pulverized coal from the pulverizer and drives it through a pipe up into a dust collector which drops it into the powdered coal storage bin and the air used to carry this pulverized coal to the dust collector is returned to the bottom of the pulverizer and used over again by the exhaustor.



FIG. 7—Great importance is laid upon the social relations among the employees, and unusual interest

waste of coal and also makes it the pulverizing plant much cleaner mills.

Distributing.

and here is a "storage system" and tank at each furnace with means of coal from the pulverizing plant to the tanks.

The feeding mechanism can be either screw or compressed air, as we have here, but air transport is so much more flexible and gives excellent results, besides being simpler in operation the screw is considered.

The coal storage bin is placed high above the transport blow tank under same.

The air system is the invention of the American Locomotive Works,

The tank is usually made $1\frac{1}{2}$ times as large as its rated capacity of powdered coal being needed for the air of

The transport line is a 4 in. regular pipe run 12 in. above the floor of the tank and runs up through top of tank with a flange just above tank top.

The bin is surrounded for not less than 6 in. distance inside of the transport tank by a movable petticoat or pipe 8 in. diameter which has about 1 ft. vertical clearance so that when down it rests on a flange cut off the coal supply.

The movable pipe is carried through the tank by a system of levers on the outside for ease of operation.

The opening valve in top of blowing tank allows the coal to flow from powdered tank as required.

The bin is placed on quick reading dial so the operator can readily see how much coal is in the bin and how much he transports to

The bin a cyclone separator is placed between the discharge end of the transport chute and the bin so that as the coal falls from

the cyclone separator it strikes on the breaker plate of distributing chute and is caused to shower down into the bin.

A switching valve is placed in transport line and piped to the cyclone separator at furnace bin so that the coal can be diverted to bin as needed.

This switch valve is so designed that it cannot choke as the warm line and branch outlets can never be closed at the same time, in addition to which there is an adjustable set screw so placed that the valve itself cannot jam or stick on seat.

A switch valve is required for each bin, except the one on end of line.

It is customary to have a pressure regulating valve placed in the compressed air supply line between the compressed air reservoir and the transport tank, so that the air in transport tank cannot become greater than 50 lb. This is for safety and economy.

Storage System.

"Storage System" where the coal is transported or conveyed in a non-gaseous mixture at furnace and then mechanically fed to the burner syphon where it is caught by primary air and sent into furnace and burned by means of secondary air surrounding the primary air nozzle.

The air pressure in most of these systems is 5 ounces for the primary and 1 ounce for the secondary or combustion, although other combinations are in successful operation, we will only describe the one we use here.

"Storage system"—In this system installed here sufficient powdered coal is stored at each furnace to operate at least 8 hours and as the quality of coal needed for one furnace is relatively small, this can be safely done and there is then no danger of shut downs due to trouble in transport or pulverizing plant.

This system also gives the operator full control of his feed and mixtures and allows each furnace to operate independent of the rest and without being affected by any other furnace.

Feeding and Burning.

The feeding mechanism consists of a small screw conveyor working in a pipe which moves the coal from bottom of storage bin and drops it through a moving screen, which prevents pulsation in the feed, into the body of the primary air syphon where the primary



s always shown in the annual picnic and field day. This panorama was taken during the 1925 occasion.

air picks it up and drives it through the coal pipe into and through the center of the burner pipe.

The feed of the coal is regulated by a shutter controller, which seems to meet the needs better than the devices previously used.

The burner pipe is arranged with a square elbow which causes the secondary air or combustion air to be broken up and its velocity reduces so that it fills the burner pipe from behind the coal and primary air, and surrounds the coal as it leaves the coal pipe to enter furnace.

The primary air pressure should be only sufficient to carry the coal to the burner and overcome the friction on the coal and air pipe.

The secondary air pressure should be regulated so it will only be a "breath at furnace".

The powdered coal should be fine enough to pass 93 per cent through a 100 mesh and 85 to 88 per cent through a 200 mesh screen and the moisture content should not be greater than 1 per cent.

The Human Equations.

In an organization where the personal contact is so highly cultivated, it is not surprising that unusual emphasis should be laid upon Safety and other educational tendencies. Every step of the way in and through this entire group of mills is a constant reminder to Think! Every activity that can be brought to bear upon the well-being and progress of the "Human Element" has found fertile soil.

The Safety Contest.*

Three outstanding features of the safety contest between the American Rolling Mill Company, at Middletown, Ohio, and the mills of the Andrews interests, namely, the Newport Rolling Mill Company, Andrews Steel Company, the Globe Iron Roofing & Corrugating Company, and the Newport Culvert Company, at Newport, Ky., make it of unusual interest to industry at large.

First, the fact that two great competitive corporations operating similar plants could get together and stage a contest in accident prevention shows Safety's grip on modern business.

The second feature to us at the Newport Rolling Mill is the nearing of the goal in a continuous accident prevention campaign which we have carried on

*Courtesy of Safety Director Kyle.

for the last year. This is more so when it is understood that nearly 2,000 employees are new men, many direct from the farm and hillside with no idea of mill work and practically no idea in unfamiliar surroundings.

The third feature, and perhaps the zeal with which these men have seized of making Safety a real part of the

The first two points can be seen. In January, we started a vigorous campaign against the appalling list of accidents which largely from breaking in a new organization the extent of over half the foremen's accidents for 1923 had averaged more than one per cent. Starting on our campaign, we inaugurated a safety dinner, in addition to our regular men's meeting. At these dinners foremen, tendents, foremen and key men of the plant discussed practices and accident prevention with subjects discussed, and by these efforts foremen, accidents were cut down from 21 in January to 8 in April.

About this time, the American Rolling Mill Company was engaged in a campaign at Newport and visited the plant and were so impressed and turned convinced that we should at once make the contest fairer, the Andrews Steel Company, the Globe Iron Roofing & Corrugating Company, Newport Rolling Mill Company, and the Newport Culvert Company, all of Newport, Ky., allied interest, combined their efforts. The one strict condition laid down was the definition of a lost time accident the same for all. Thus, a lost time accident was one in which the injured man was unable to perform his regular duties without help for a period of time. The one condition was that on which the accident occurred which compensation was paid to the injured man regardless of whether he lost any time or not.

Our mills at Newport were each divided into general according to the class of work and chairmen were selected for each group of workmen, who in turn selected their own men. These committees were given

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any unsafe practice seen by them, and were the ers of their groups through the campaign. The aps were pitted against each other to make a ord for May. May 1, in spite of rain, blossomed with the plants decorated with safety signs, slo-s, and descriptive sets.

All who entered the plant, visitors or workmen, e compelled to wear badges, caps or other insignia, a their group number, showing they were safe able to take care of themselves. It was impossible anyone not wearing such identification to get the gate or enter any department without being

of the month and for every day without an accident a green light was substituted, and a red one for a day on which an accident occurred. On the last day of April, "Old Man Carelessness," much bandaged, spotted with red paint, limped through the plant on crutches, chased by a neat workman representing Safety; on May 1 an imitation grave appeared with a tombstone declaring that "Old Man Carelessness" was buried there forever. Another group hung the same offensive "Old Man Carelessness" from a pole on a boat in the reservoir, and drowned him, inch by inch, as the month went on without accident to one

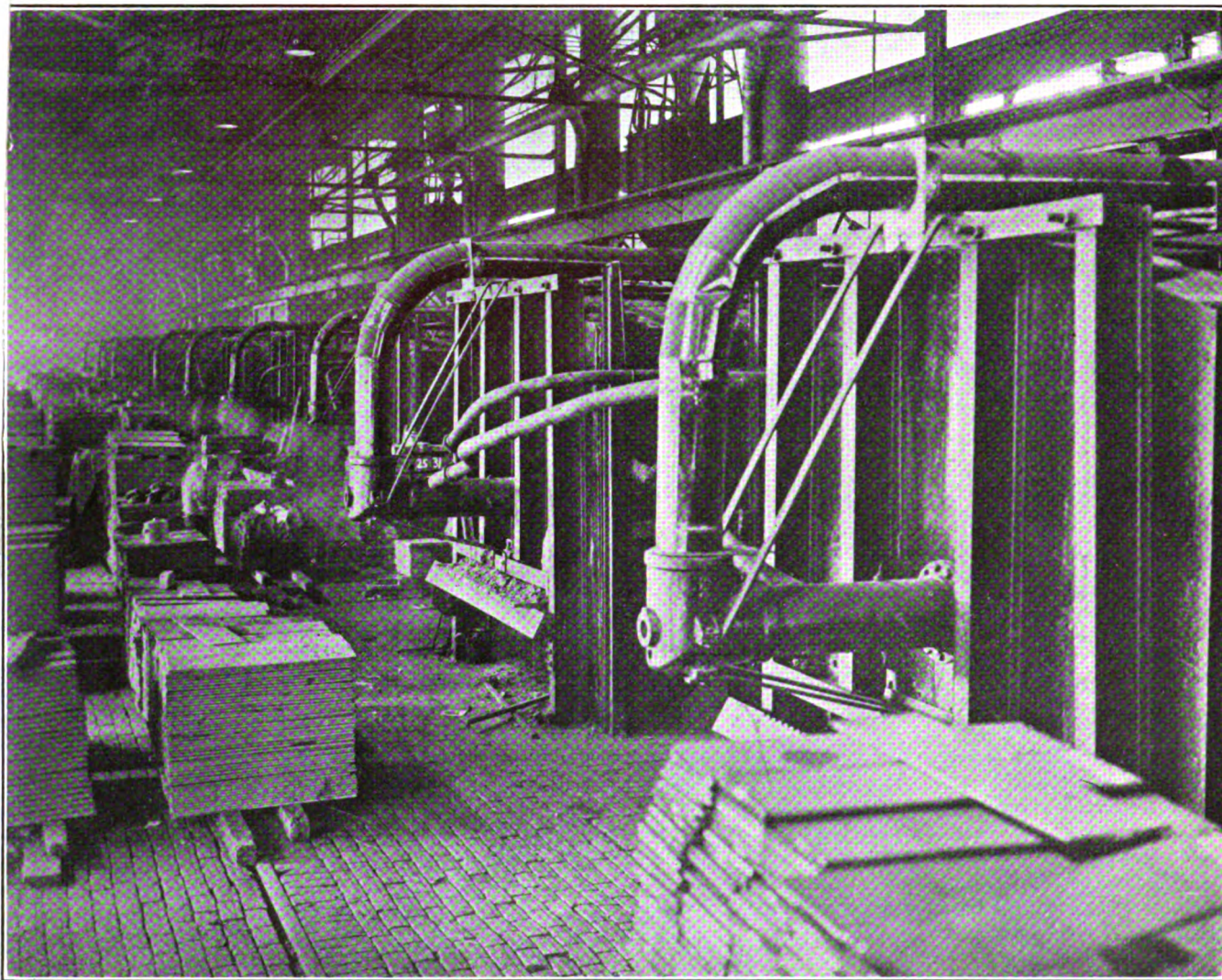


FIG. 8—Rear view of Hagan designed heating furnaces showing burner attachments and supply pipes.

costed or even put out until some one known to ie committeemen would vouch for him and provide m with a safety badge. This was probably the most fective weapon employed against accident, as it conuually impressed every workman with the importance of being safe himself, and thereby holding up the onor of his group. The group spirit grew keener and brought out many unknown artists and slogan akers.

A large electric sign proclaiming Safety was in-called conspicuously, while directly over the gate was a sign demanding that anyone not safe must stay ut. An electric sign with 31 lights, outlining the word "May" was started with white lights on the first

of their group. Still another group took a dummy similarly labeled and crushed it to bits under the skull cracker. This group has not had an accident since.

These and many more stunts were thought out and executed by the workmen's committees to visualize to their fellow workmen the idea of safety. That they succeeded is shown by the figures on the large score board at the main gate at the end of the month, which were two slight lost time accidents at the Newport Rolling Mill for the month of May as compared with a total of 3 for the four months previous, and one such accident at Andrews Steel Plant, compared with 17 the four months preceding. The American Rolling

Mill at Middletown also had three lost time accidents, making the contest a tie. So the contest went on into June; with the month one-third gone, the score stood at zero for all.

As mentioned in the beginning, the greatest feature of this campaign was the fact that the workmen "put it over." They visualized the idea of safety so plainly in their tableaux, signs (some of which were even threats of discipline) and continued talk, that no one could help grasping the idea that it was up to him personally to be careful. While some stunts bordered on horse play, we feel convinced that they have all been effective in making every one in our plant use his own brains to help stamp out careless and thoughtless actions.

the feeling of satisfaction of a job well done was engendered all over our plants. The only department with reduced output was the hospital, where treatments were cut down at least 60 per cent.

The Newport Rolling Mill Company have also set up high safety standards. Many methods of instilling this idea of accident prevention into the minds of all employees, such as visual signs and cautions and usual educational talks, dinners, etc., as well as personal individual educational meetings with workmen by safety directors and committees. One of the best stunts and one which has been used for over a year is the wearing of a common safety pin by every workman while at work under penalty of a small fine, the proceeds of which are added to the childrens play

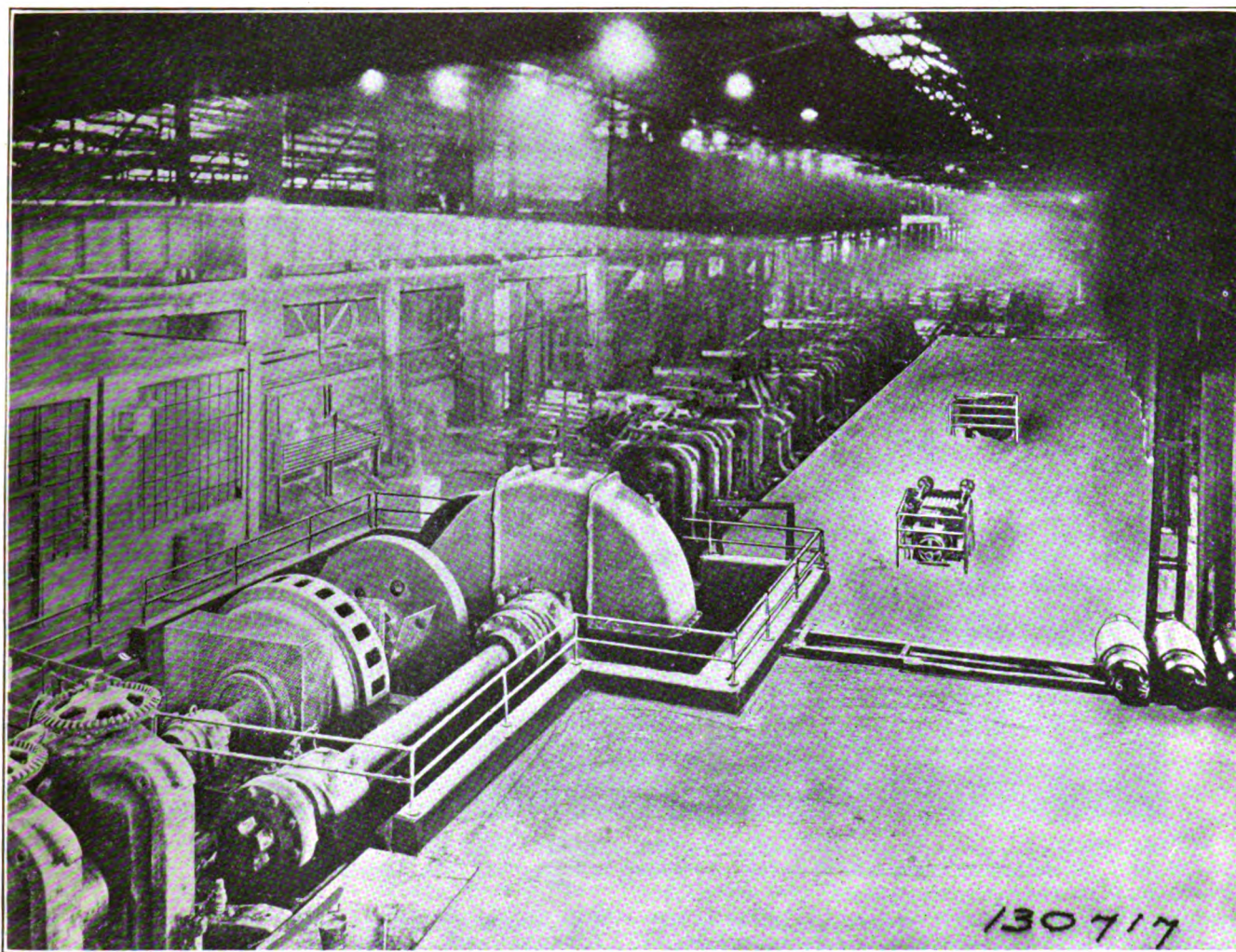


FIG. 9—A view of the sheet mill layout, showing prominently the main motor drive, reduction gear and flexible coupling.

The campaign not only educated our entire working force toward safe practices and sanitary conditions, but brought about much better relations among the men themselves, thereby cementing our organization together both for work and for pleasure. This is shown by the spontaneous formation of an orchestra, a baseball league, and other employee organizations by the men themselves.

That such a campaign is soundly economic is shown by the marked improvement in the quality of work, as well as the maintaining of production in all departments. Added zest was put into the work and

ground fund. The fundamental idea of the safety pin is that when the employee checks up each morning to see if he has his safety pin he consciously thinks of the safety pin motto, i. e., "I Am Not Going To Get Hurt Today". The results of this stunt have been beyond expectation and is one of the best yet tried.

The Foremen's Club Movement.*

The Foremen's Club movement got its start in Southern Ohio, in 1918, at the completion of a Course in Foremen Training, held at the Y. M. C. A. in the

*Courtesy Mr. Edgecomb.

City of Dayton. The men who took this Course formed a Club, and this club has been followed by other clubs in adjacent cities.

The Club in Cincinnati was formed in October, 1294, and at the present time has 700 members.

The aim of the Foremen's Club movement is to bring to the Foreman a realization of the importance of his position; to help him analyze his functions; to help him solve his problems; to teach him the fundamental principles underlying the handling of men; to get him familiar with sources of information and methods of obtaining it; to elevate the position of foremanship to a higher plane, and to a better recognition by society; to educate foremen in the principles

Also in connection with the Club there is an Educational side, which is tied up with the Vocational Educational Department of the State University and the United States Government, whereby the Foremen are given the opportunity of taking a Course in Foremanship Training by the conference method, which appears to be the best method developed so far in the training of foremen.

The dues in the Club are kept as low as possible, in order to include the minor foremen, and in the Cincinnati Club the yearly dues amount to only \$2.50.

In order to unify the movement, which spread from its beginning in Dayton about 2½ years ago, a Federation was formed, in which was combined the

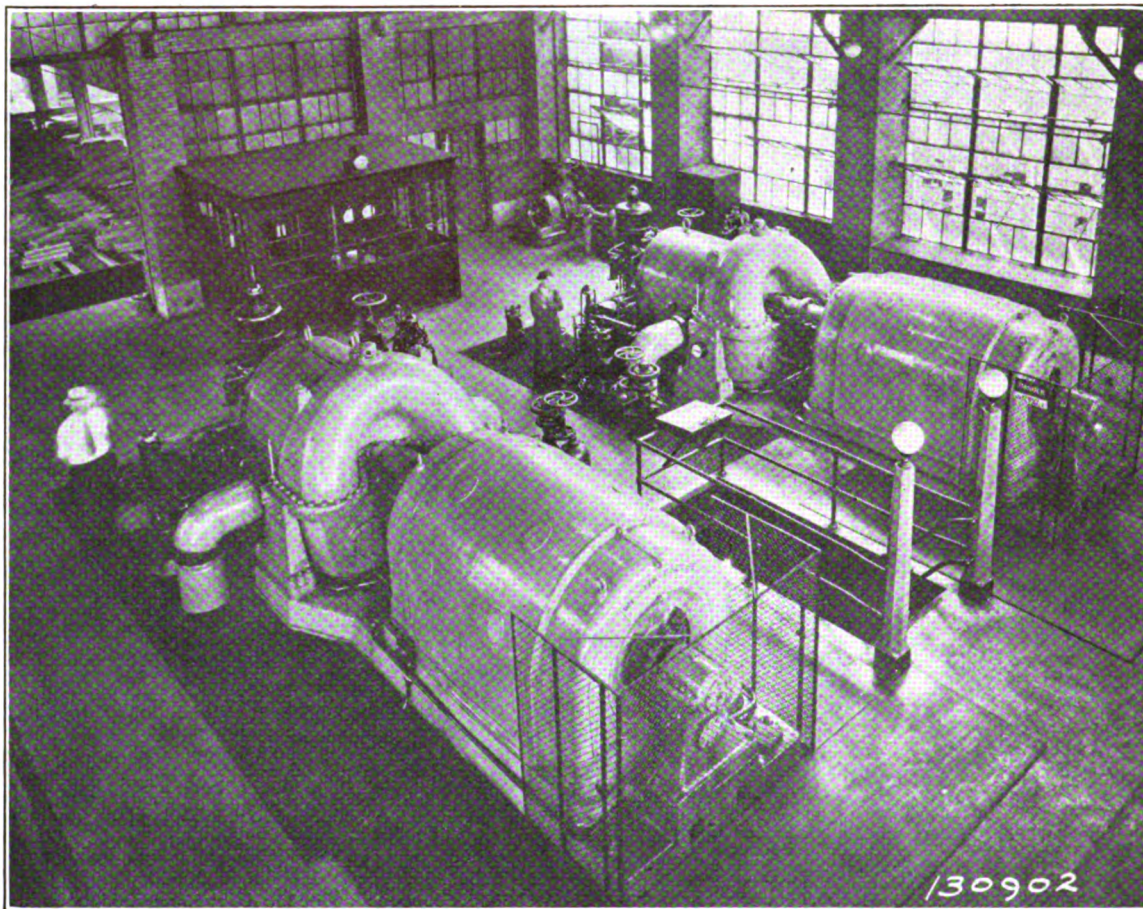


FIG. 10—Interior view of the main power-house where exhaust steam from the blooming and bar mills is recovered to produce electrical energy used in driving the sheet mills and auxiliaries.

and ethics of good business; to stimulate foremen to greater effort through contacts with men of high mental caliber, and to give the Foremen an opportunity to meet socially men occupying similar positions with other companies.

The movement is non-sectarian; non-political, and takes no stand in connection with unionism.

Meetings are held monthly (with a two months summer vacation), which are preceded by a dinner at nominal price; a short order of business, which is followed by a speaker and sometimes with a plant inspection afterwards.

Two or three times during the year social functions are put on to which the men's families are invited. These social functions consist of sometimes a boat ride or a picnic, or a theatre party, or a Christmas party, and the like.

then existing Clubs in Ohio. This amalgamation was called the Ohio Federation of Foremen's Clubs.

On October 8, 1925, at the semi-annual meeting of this Federation, it was desired to further increase the scope of the Foremen's Club movement, and to form a National body. This was done, under the name of the "National Association of Foremen."

It was found that there were isolated Foremen's Clubs—some in factories and some city wide, in isolated sections, extending from the Atlantic to the Pacific, and the National Association of Foremen hopes to gather these isolated Clubs into a working unit, which will be nation wide.

There are at present in the National Association of Foremen about 4,000 men.

(Concluded on page 48)

A Review of Metallurgical Progress

The Last Year Has Focused Attention Upon Many Important Innovations—Experiments Now Become Practice

By S. B. GOODALE*

A STUDY of the metallurgical literature of the past year gives strongly the impression that there is no more pronounced and important tendency in developments in the widely varied fields included in the metal industries than the increased application of scientific principles. Other single points strongly emphasized are the energetic effort to secure uniformly higher quality in product, and the necessity, forced by close competition, to keep costs down. In the effort toward bettering quality, more emphasis is being laid upon securing a uniformity of high quality, than upon raising quality unless the better results so secured can be uniformly secured. Very careful study has been put upon the question of securing low costs, while keeping up production, and maintaining or improving quality, and still without reducing wages.

In the field of the blast furnace, the United States Bureau of Mines activities have been continued, with increasing appreciation from the industry in general. The American Institute of Mining and Metallurgical Engineers and the Engineers Society of Western Pennsylvania have held important special conferences on the open hearth and on the blast furnace, calling together for these conferences a large number of the important operators in these lines.

The question of sulphur in the blast furnace was discussed by Mr. T. L. Joseph before the Mining Engineers at their February meeting. It would seem as if a greater part of the energy directed to the study of eliminating sulphur in the blast furnace process might be directed to the practice of removing sulphur from the coal before coking. This study could also include the possibility of reducing the ash content; and, while a great deal has been accomplished along these lines, the majority of the coal used for blast furnace coke is still run into the ovens without much or any attempt at cleaning.

Another paper of interest at this meeting was that of Heihachi Kamura, of Japan, on the reduction of iron ores by carbon monoxide. After reduction, steel may be made directly in an electric furnace from the iron sponge; but it will probably be necessary to cool the sponge sufficiently out of contact with air so as to apply magnetic separation to remove the gangue. This subject is referred to further below.

Several of the United States Bureau of Mines studies will be referred to. Mr. Ralph Sherman reported results of an extensive study of the combustibility of blast furnace coke. This study has given data of fundamental importance, although it is doubtful if the data secured will quickly bring about any marked changes in either blast furnace or coking practice.

The study of the combustion of coke in the tuyere region of the blast furnace has confirmed earlier results, and seems to have yielded a more definite idea

of the conditions in this part of the furnace. It appears that all the oxygen of the blast has been converted to carbon monoxide by the carbon of the coke within a distance of some 32 to 40 in. from the nose of the tuyere, and this without regard to the so-called combustibility of the coke mentioned above. There is no such thing as penetration of the blast to the center of the modern large hearth furnace. The very interesting question then exists as to what is going on in this central region of the furnace. How active are the reactions of reduction of the iron oxides or of the metalloids? What are the temperature and composition effects on the pig iron of this large central zone? Does the productive capacity of the furnace increase with the square of the diameter, or merely in direct proportion to the increase in hearth diameter? If the really active zone is merely an annular area of something like 40 in. in width and of the length of the circumference of the hearth or less, it would seem as if the productive capacity would increase directly with the increase in hearth diameter, or perhaps at a slightly higher rate; but certainly not so rapidly as to be comparable with the square of the hearth diameter, that is with the areal increase.

An air blast burning an excess of coke normally leads to a gas composition of about 34 per cent carbon monoxide and 66 per cent of nitrogen. Mr. Kinney, (this journal, June, p. 243) reported finding gas compositions in the central portion of the hearth of a furnace at the tuyeres, of something over 50 per cent of carbon monoxide. The excess carbon monoxide may be accounted for by direct reduction of oxides by carbon at the high temperature of the hearth, or by any reaction that would remove nitrogen from the gas, such as the formation of cyanide, or perhaps by a combination of these causes. The high cyanide content of some samples of gas caught from the slag notch points to an important cyanide formation in this region. Messrs. Kinney and Guernsey reported an extensive study of the alkali cyanide in the furnace, (this journal, October, p. 395). They discuss the possibility of withdrawing some of the gas for the recovery of the contained cyanogen content, and conclude that it may be possible to secure cyanide in this way to the extent of perhaps some 3 per cent of the value of the iron made, without too great adverse effect upon the operation of the furnace as regards its product of iron.

Another Bureau of Mines report, made also by Mr. Kinney, concerned furnace temperatures. It was there shown that the iron running about the middle of the cast is hotter than that coming either earlier or later, being some 130 deg. above the average metal temperature of the cast. A very interesting point brought out is that the slag temperature remains approximately constant in accordance with Johnson's theorem regarding the free running temperature.

Some details of blast furnace practice at the Tata plant, situated about 150 miles from Calcutta, India, were published recently in a paper before the Iron

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and Steel Institute at London. (Abstracted this journal, November, p. 426). The interesting points appear to be the production of iron economically using a soft coke of high grade ash content, and the fuel economy secured by certain changes in the furnace lines. Since charcoal is soft and of the highest combustibility, and in most cases gives good fuel economy in the furnace, we might ask why not also good fuel economy with soft coke?

American manufacturers of charcoal pig iron have met serious competition in regard to their principal by-product, wood alcohol, in the synthetic product, methanol. The cost of making this methanol is reported to be 87 per cent less than that of wood alcohol. The effect of this development on the charcoal iron industry may be very severe.

For many years the blast furnace was without competition, the sole starting point of all metal in the iron and steel industries. It occupied many years in achieving that position, and driving the direct production of malleable metal from ore out of commercial operation. The development of the electric steel melting and refining furnace has brought a renewal of the effort to make the production of malleable metal in a more direct fashion successful in a large commercial way. Also another development of the electric furnace, that in the reduction of pig iron, has brought in an element to compete directly with the blast furnace. Then there are developments in electrolytic iron which are still on a very small scale but which give some promise of development to large proportions in time.

Iron ore reduction can be carried on at very moderate temperatures. Kamura, in Japan, Flodin, of Stockholm, and others propose to do this in a moderate temperature furnace, then cool the metal away from air, separate it from the gangue magnetically; and then melt and refine in an electric furnace. At the September meeting of the Iron and Steel Institute of Great Britain, a paper was presented by Mr. Henning Flodin, describing work done on an industrial scale at Hagfors, Sweden. The ore is reduced to malleable iron or steel in one continuous operation. One hundred and fourteen tappings were reported to have been made, producing various grades of steel at will. The gross energy expenditure reported in the furnace was some 2,162 kwhrs. per ton of iron, so that it would seem to be necessary to have very cheap electric power available to make the process commercial. Why not work up the total power possibilities of our modern blast furnace and coke oven plants to a very efficient point and use the surplus power in this way?

Production of electrolytic iron sheet, as practiced at Grenoble, France for several years, has been introduced successfully at Niagara Falls. The process used resembles the Elmore process for producing electrolytic tubes of copper, which was worked in several places abroad over 20 years ago, in that the cathode is a rotating round mandrel; but it appears that in the present instance the electrolyte requires regeneration as a separate operation, and there are certain other important differences, partly chemical and partly mechanical. The product is claimed to be applicable for deep drawing, and for anti-corrosion uses because of unusual ductility and purity. It would seem as if a wide market should develop for such a product, and require an expansion of this plant far beyond the present intention reported at 7 tons per day, if the cost

of the material is low enough to compete with other products available for similar uses.

In the field of foundry work a great deal of attention has been given to the important subject of molding sand. The bonding properties, as a feature distinct from the refractoriness has received much attention. Two sessions of the meeting of the American Foundrymen's Association at Syracuse, N. Y., in October were devoted to foundry sands. Some foundries are reported to have operated for many months without new sand, merely adding various proportions of bonding material to their old sand, and then mixing very thoroughly.

Mr. J. E. Johnson's conclusion that the high strength of charcoal iron was due to the contained oxygen, and the effect this has on the graphite, was put in added doubt by results presented by J. R. Eckman and Louis Jordan of the United States Bureau of Standards. They reviewed the methods of determining oxygen in iron and described a new vacuum fusion method of the Bureau of Standards. Their results indicate slightly more oxygen in the weaker irons.

The effect of nickel and chromium in cast irons was covered in a long report by Messrs. T. H. Wickenden, and J. S. Vanick, of the Research Department, International Nickel Company, New York. The effect of phosphorus on the total carbon content of cast iron was reported on by Mr. J. T. McKenzie, of the American Iron Pipe Company, of Birmingham, Ala. Both of these papers contain a great deal of new data.

The subject of silicon in cast iron has been subjected to further study. Mr. A. H. Schwartz, and Mrs. Anna Nicholson Hird, of the National Malleable & Steel Casting Company of Cleveland. Ohio reported before the February meeting of the Mining Engineers on the "Chemical Equilibria During Solidification and Cooling of White Cast Iron." Their major conclusion seems to be that equilibrium is secured when, during solidification the silicon is all in the liquid phase, that is, the austenite separates, or freezes, silicon free. The data was secured by analyzing cementite separated electrolytically from white cast iron of known composition and treatment. Information was also secured in regard to the distribution of manganese and phosphorus.

The temperature of cupola iron is capable of considerable control. The subject was presented by Mr. S. J. Felton, of the Ohio Mechanics' Institute, Cincinnati, but there seems to be an increasing tendency to use the electric furnace to superheat cupola metal, the so-called Elliottizing of Cupola iron. This treatment is capable of giving more uniform results, perhaps, than can be secured direct from the cupola. Besides which it gives opportunity for adjusting the composition of the iron somewhat, if desired.

The correct gating of patterns for foundry work is emphasized in a paper by Mr. H. A. Russell, and comments thereon by Mr. E. O. Keator in the Iron Age, vol. 115, p. 1331, and 1660. This is a question affecting quality and cost in the finished castings, and frequently an improvement in gating may lower costs, cut down losses, and improve quality.

A paper on "Peeling in Malleable Iron" presented at the May meeting of the Iron and Steel Institute of Great Britain, by Mr. Douglas H. Ingalls, M.Sc., County Technical College, Wednesbury, and H. Field Willenhall, was extensively discussed, and much in-

formation in comparison between the English and American practice brought out, as abstracted in the *Iron Age*, vol. 115, p. 1569. For instance English practice permits sulphur up to perhaps .40 per cent in the iron, a limit much above that permitted in the United States.

Centrifugal casting of gray iron which can be machined readily without intermediate annealing, and of a size up to 36 in. diam. is reported at Centrifugal Castings, Ltd., at Kilmarnock, Scotland. (*Iron Age*, vol. 115, 1704). It is claimed that these pipes are the largest centrifugal castings yet made commercially.

Very interesting results on the heat treatment of cast iron were presented at a meeting of the Chicago Chapter of the American Society for Steel Treating, by Mr. Fred Grotts, of the Hold Mfg. Company, Peoria, Ill. For instance, chilled iron may be malleablized by being annealed for about three hours at 1750 to 1800 deg. F., and then quenching in water, and drawing at 1200 to 1300 for 15 hours. This process does not yield the ductility of the ordinary malleable but rather an intermediate product. Or chilled iron may be softened for machining by a shorter treatment; and after machining can again be hardened to about the equal of the original chill. Mr. E. A. Custer, of the Schaap Iron & Steel Corporation, claims that he did similar work much earlier, but comparatively little practical applications seem to have resulted.

An electrically heated ingot soaking pit was installed at the plant of the Donner Steel Company, in Buffalo, in March, 1924. The resistance elements are of crushed carbon of about ¼-in. mesh, contained in silicon carbide troughs in the side walls of the pit where they cannot be hit by the ingots. This is about the only heating element that will stand soaking pit temperatures with satisfaction. Mr. T. F. Baily, of Alliance, Ohio, presented some results of the use of this furnace, before the Iron and Steel Electrical Engineers in Pittsburgh, in January. Detailed figures are given in the paper, (*Iron Age*, vol. 115, p. 617). The lower scale loss over heating in gas fired pits will go far to compensate for the higher electrical cost for heat; besides which it was found that less power was needed in the rolling of the electrically heated steel, indicating a more uniform heating through the ingot.

The use of resistance electric furnaces with metal resistor units has been increasing rapidly during the past four or more years. The advantages of such furnaces in quality of product, and in convenience of operation and good temperature equalization throughout work, together with better temperature control, are rapidly becoming more generally appreciated. No specific development of any revolutionary kind however has come to the author's attention during the year.

Another electric furnace in which development has been very rapid is the high frequency induction type, invented some years ago by Dr. E. F. Northrup. This is being widely applied in convenient forms for melting small quantities of metals under special conditions as in vacuum, or under hydrogen, etc. In certain cases it is being used on a fairly large commercial scale.

Electric welding is a special form of electric heating which is very rapidly growing in importance. For instance the 63 to 66 in. pipe of the Mokelumne River water supply system is planned to be electrically welded. At the meeting of the American Welding

Society, in April, at the United Engineering Societies Building, New York, a symposium was held on the methods of inspecting welds and testing and checking the skill of welders. A paper was published in the *Iron Age*, vol. 115, p. 1051, by Mr. W. Spraragen, secretary of the American Bureau of Welding giving an excellent summary of the economies secured by the use of electric welding in structural work. He concludes on this line: "The combination of all these factors makes it possible with the use of welding to produce a structure which is cheaper and better than the ones constructed by riveting." He states that up to now "most welded structures have not been proportioned with proper regard for stresses to be carried." Generally the design was for riveted construction, and then a change to welding was made. Joints designed for riveting do not always make good welding possible, and if welding is to be used the structural parts should be so designed, many small welds may well be used rather than one large heavily stressed weld. Conscientious operators are necessary, and careful inspection, and then under proper conditions electric arc welding has great possibilities in economy and better construction.

In the microscopic examination of steel, the effect on the prepared surface studied of the manner of preparation of this surface is of prime importance. The true structure of metal can only too easily be obscured by improper polishing or careless handling. Mr. Geo. F. Comstock, of Niagara Falls, has published data on some of the precautions necessary in preparing and judging specimens. Two other papers on this subject have been published during the year in vol. 7, of the Transactions of the American Society for Steel Treating, one by Messrs Burgess and Villela, of the Union Carbide & Carbon Research Laboratories, and the other by Mr. B. G. Guthrie, of the Peoples Gas Light & Coke Company, Chicago. Workers in this field may study these papers with profit. A paper presented before the Cleveland Chapter of this Society by Mr. J. Fletcher Harper, (reprinted this journal, p. 150) gives the results of extended studies of what can be revealed by deep etching of samples by strong hot acids.

Attention may well be called to an excellent series of papers that has been running in Forging-Stamping-Heat Treating by Mr. H. C. Knerr, Chief Metallurgist, Naval Aircraft Factory, Philadelphia, Pa., on "A Practical Course on the Elements of Physical Metallurgy."

X-ray studies have been actively continued during the year. These studies have, some time since, passed the point where every author feels the necessity of explaining the method of operation, and now, more and more, the applications of fundamental data which have been secured, are being written about. Two papers, particularly, may be mentioned here, one by Messrs. Robert J. Anderson and John T. Norton, at the meeting of the Mining Engineers in February, in which is presented data and argument to disprove the correctness of the hypothesis of the occurrence of amorphous metal in the polished surface of metal. The conclusion is reached that such surfaces consist of very fine crystalline fragments. The second is a very brief paper by Mr. Foley, along the line of explaining the condition of the intergranular cement in metals, as not being of an amorphous nature, but a strained arrangement of the atoms, under definite interatomic forces between the crystals.

The use of X-ray also for examination of castings for soundness and foreign inclusions has progressed notably. An important report on this subject was submitted at the Atlantic City convention of the American Society for Testing Materials. Dr. Ansell St. John, of New York City, reported that fluoroscopic examination may replace the photographic, and results be secured much more rapidly and at less cost. Dr. St. John worked out something as to the size of flaws which may be detected by this method. This was arrived at by examination of synthetic samples made up of thin sheets, in which holes of known size and location were drilled. By having the holes through only one, or a known number of thicknesses of these sheets, the effective size of the opening and thickness of metal left were known.

Dr. John A. Mathews, vice president, Crucible Steel Company of America, in the Henry M. Howe Memorial lecture before the American Institute of Mining Engineers, and in a later paper before the American Society for Steel Treating, at Cleveland, presented a very large amount of experimental evidence on austenite and martensite, and some new views on the subject of gamma iron metallurgy. In the Howe Memorial Lecture, he reached three main conclusions, contrary to generally accepted ideas, first, that "in all normally hardened medium or high carbon steels, and the usual engineering alloy steels gamma iron, or austenite, is always present with martensite." Second, "In a wide variety of alloy steels, notably those capable of hardening readily in oil, there is more austenite present after oil quenching than after water quenching for normal hardening." Third, "Austenite is considered to be a cause of increased permanence, or retentivity, in those alloys capable of hardening readily in oil." In concluding his second paper Dr. Mathews said that there was much needed, in particular, a quantitative method for determining the amounts of gamma and of alpha iron present in any sample. The writer of this review that it is hoped, that when this method is found, it will be capable of giving new light, at least, on the question of beta iron. As mentioned by Dr. Sauveur in his lectures at the Carnegie Institute of Technology, Pittsburgh, in December, there are still a number of believers in beta iron as an allotropic form of that metal, whether it be of commercial importance at present or not. Perhaps new information on the subject may make beta iron really useful.

The most prominent present tendency in alloy steels is that to stainless or rust-less or "stable-surface" iron, a name suggested by Mr. P. A. E. Armstrong, of Watervliet, N. Y., in a paper before the spring sectional meeting of the Steel Treating at Cincinnati. He predicts the development along two lines, one of a steel that will be highly corrosion resisting, the other of a steel that will resist progressive rusting over very long periods, but is not indestructible. There is a very large possible market for sheets and tubes of a rust resisting character.

In connections with the developments of anti-corrosion steels the recent developments along electroplating with chromium deserve very favorable mention. Electro deposited chromium is extremely hard. A process of chromium plating, developed by Mr. H. E. Haring, of the United States Bureau of Standards, has been applied to certain plates for printing at the Bureau of Engraving and Printing. These plates are

reported to have given very good service. "Crodon" is the trade name of chromium plate, as developed commercially by Dr. Colin G. Fink for the Chemical Treatment Company, Inc., of New York City. Dr. Fink summarizes its many applications in Forging-Stamping-Heat Treating for June. Mr. Geo. M. Enos, of the University of Cincinnati, presented a brief paper on this subject before the American Electrochemical Society at Chattanooga, Tenn., in September, together with a good bibliography.

A steel with manganese running about 1.25 per cent, and carbon .30 per cent is advocated by Mr. John Howe Hall, of the Taylor-Wharton Iron & Steel Company, for steel castings, and, incidentally, has been used for many other purposes. This paper (Iron Age, October 1) summarizes the results of a great many tests.

At the annual meetings of the American Society for Steel Treating, at Cleveland, in September, a great many valuable papers were presented. The subjects of tool steel, high speed steel, carburizing, and hardness testing received much attention. The Transactions of this Society have taken a high place in originality and high quality of papers during its rather brief life.

Experiments with oxy-acetylene cutting, made by the Union Carbide & Carbon Research Laboratories, Long Island City, New York, and reported by Mr. E. E. Thum, show that the effects of the heating, etc., due to cutting seldom, if ever, extend more than $\frac{1}{8}$ -in. away from the cut, into the metal and, then are usually not such as to damage this metal. Cutting by the oxy-acetylene torch generally in fact damages the piece less than cutting by other means.

In the field of quality in finished metal, including testing, metallography, etc., many able workers have been active. While the publications in these fields are scattered through many different journals, and the transactions of many societies, yet it is probable that many of the most important developments and discoveries have not yet been published. The author regrets that his time has been very limited on this review, and feels that, especially in this field, much more study of the literature, and correspondence with a number of workers, would be necessary to bring out anything like a complete review of the year's happenings. What is presented is merely a portion of what has come to his attention and seems most to call for mention here.

Combustion Control

American Heat Economy Bureau, Inc. report, the following additional orders for Steinbart Combustion Systems: Illinois Steel Company, Gary, Ind., 16—400 hp. boilers; Carnegie Steel Company, Carrie Furnaces, Homestead, Pa., 8—Stoves Nos. 1 and 2 Furnaces; Carnegie Steel Company, Edgar Thomson Works, Rankin, Pa., 8—Stoves Nos. G and H Furnaces; Midland Coke & Iron Company, Granite City, Ill., 3 Stoves and 3—800 hp. Boilers for a new furnace; Weirton Steel Company, Weirton, W. Va., 3—Stoves for No. 1 Furnace, 4—Stoves for No. 2 Furnace, 6—900 hp. Boilers.

They are looking back on the greatest year of their history. The orders taken for the Steinbart Combustion System and Huessener Regenerative Control exceeded a total of \$750,000.

Vision—Prime Essential for 1926

Trend Toward Simplification—Science and Engineering Now Dominant

By RUSSELL BYRON WILLIAMS*

INTROSPECTION calls forth retrospection. Without the perspective provided by yesterday we cannot properly view tomorrow. It is not only fitting but necessary, therefore, that we take into consideration past events before discussing present indications. This, however, can be done in one statement: Engineering and science have assumed control. In that statement is wrapped all the development of the past 50 years. In it will be found deeper-going and farther-reaching effects than can be found in any other statement relating to commercial affairs. Science and engineering have taken command—with the result that we are entering upon an era of industrial expansion and activity without parallel in history. This contention is supported by evidence on every hand. Never have we had so much on the constructive side of the ledger to contribute to optimism. So true is this that the manufacturer, wholesaler or retailer who does not make money during 1926 will have only himself to blame.

Let no one believe, however, that the business prosperity that is most certainly here to stay will bestow its fruits upon everyone wishing for endowment. As never before hard work and vision are prime essentials to profit. Because science and engineering are now in the saddle we are moving with great rapidity. The trend of today is toward simplification and unity. There is no longer a "backwoods section" of the United States. Few, anywhere. The world is getting acquainted with itself. An important discovery or a vital message is known the world over twelve hours after delivery. Discussion of world events, at the time they happen, is now commonplace.

Outside the field of communication we find all industry moving with a speed heretofore unknown. While it took hundreds of years to progress from the stage coach to the steam railroad, it took but twenty years to develop the automobile. Eighty years were spent in the development of the telephone; four years, the radio. In fifteen years we not only learned how but adopted the methods whereby we could extract indigo from coal, and thus almost wipe out of existence an industry that had flourished in India for a hundred years. The development of rayon has thrown thousands of Japanese silk worms out of employment, and imposed a tremendous production burden on our own textile and paper industries,—all in ten years.

Had railroad executives possessed the vision of Haynes and Ford 25 years ago, they would have built concrete roads along their right-of-ways, paid for them through tolls, and thus capitalized their competitor, the automobile, at the same time obviating the necessity for state governments to expend enormous sums for highways which must be met with taxes. The phonograph folks lost millions in reduced machine and record sales before they learned the wisdom of recognizing and co-operating with their competitor, radio. Electricity has outstripped manufactured gas

as a utility largely because the gas men have kept their eyes glued to the kitchen range, to the exclusion of the larger opportunities in house heating and industrial usage. Criticism and protest from street-car companies failed to obviate the necessity for either serious competition or straight-forward co-operation with the motor-bus. Not ten per cent of the wood furniture manufacturers were prepared to meet the competition of steel. We move rapidly now-a-days, and the end is not yet. Hence the need for vision.

It is a trait of human nature to unsuccessfully visualize coming changes. We are all too prone to view tomorrow by what we know and do today. Our foresight is never as good as our hindsight, and too often we believe that by guiding our steps by past experience we are performing wisely. That trait has cost us untold millions. The characteristics in human nature that makes us reluctant to accept anything that may disrupt the even tenor of our ways has cost us incalculable commercial progress and uncounted years in development. In spite of all the lessons of history we are wont to live and think in terms of the present. Tomorrow, for most of us, is a negative quantity, and we therefore just sit tight and take our chances. With emergencies arising as rapidly as they are today, this is dangerous practice.

There is no lack of evidence of the value of vision. Proof of the dollars and cents reaction from the exercise of foresight is on every hand. Mr. Hill believed in that barren expanse lying west of the Red River of the North—and he built the Great Northern railroad. The Astors and the Vanderbilts invested in Manhattan Island property long before the average man could dream of the extension of New York City. At the time these men started they had no more money than we. Just greater foresight—and an absence of the reluctance to take the necessary steps. The American Telephone and Telegraph Company even now has cables stretched across the continent sufficiently large to care for increased population and demand for the next 50 years. When radio began to flare into popularity that company lost no time in securing for itself a dominating position in its development. Because of this action, they are now so large a factor in the radio industry that they can largely shape the course of its development. No stone is left unturned in their search for inventions that may have even a remote influence on their business. They recognize the truth that all industries are closely inter-related,—that a development in the manufacture of one product may seriously affect a totally different product.

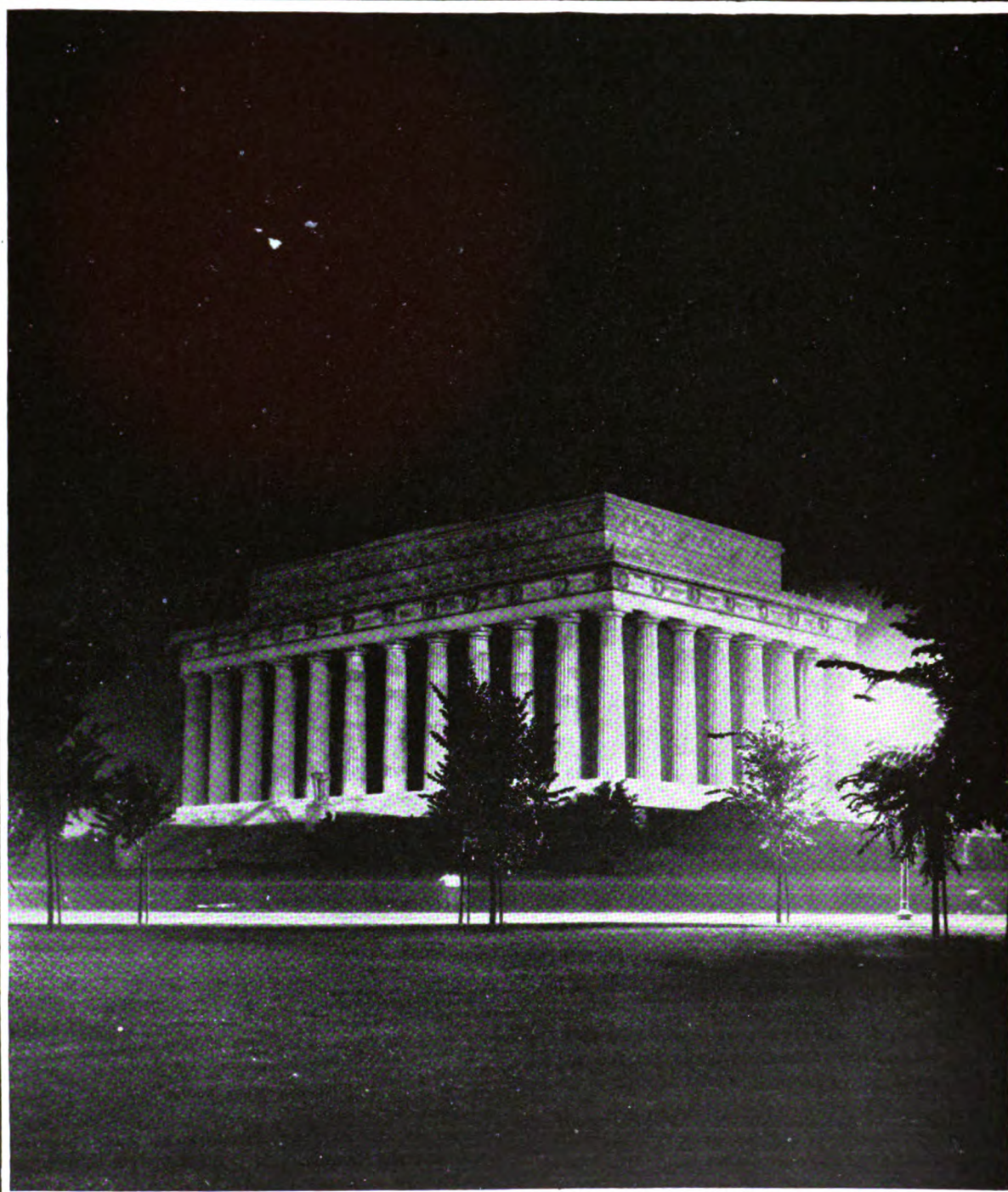
What Has Been Done.

If we are to look ahead with vision—that we may look backward with pride—we must recognize what has gone before, then keep in touch with the trend of times. Here are a few of the developments of 1925 that may have passed you by unnoticed.

Radio has been spoken of. Let us look at just two of the multitude of developments that have been

*From the author's address before Central States Ass'n.

*A Magnificent Addition to Washington's
Architectural Masterpieces*



LINCOLN MEMORIAL

An inspirational Monument to a Man of Vision

—Courtesy General Electric Monogram.

brought forward—then drop its consideration for more concrete things. Experts have recently perfected an ultra-audible microphone, one that will pick up insect voices. This microphone, working in connection with the device that transmits mirrored reflections, opens up a whole world of sound and activity for scientific and practical research as yet untouched. Another man has perfected a little $2\frac{1}{2}$ in. cylinder through which only certain sounds can pass. This means that all sound entering the radio can be filtered and that there will be complete elimination of all static. Radio will play, also, a very important part in transportation. Aviators are not greatly impressed with ground lights. Too often weather conditions render them ineffective. Radio, whereas, is always dependable. It will be used to guide airplanes in night or trans-oceanic flight—and freight planes by day. Not long hence, freight planes carrying Montana wool or Georgia cotton to the textile mills of New England, will have no need for men, but will be guided entirely by radio. Dispatched by one station they will be caught by another.

At one of our large eastern laboratories, roentgenologists have developed what is known as the Gamma Ray. This electrical ray makes possible the ionization of our endocrine glands. Through such ionization the progress of old age can be definitely retarded, according to one of the directors of this concern. If his statement be true (and considering other developments we do not flatter our intelligence by being overly skeptical) we stand today on the threshold of an era in which the halting memory, the wrinkled skin, the stiffened joints, the listless gait, the lusterless eye, will all be eliminated, or at least definitely retarded, through the application of the Gamma ray. Perfection of this scheme would enable us to retain our physical vitality and mental activity far beyond the age of 90. Recognizing the fact that in 1789 the span of life averaged 35.7 years, whereas the period of expectancy at birth now extends over 55 years, the realization of such results as those claimed for Gamma ray seem not impossible.

Making Hens Lay Five Eggs a Day.

You were entirely justified in your belief that a hen could lay but one egg a day—until last year—when scientists discovered that through the application of the ultra-violet ray hens could be made to lay more than their time-honored quota. In one experiment, with a hen that laid 29 eggs in January, she actually laid 147 eggs in February—simply through the application of the ultra-violet ray. This scheme, furthermore, is no more harmful to the hen than the employment of electric light, which poultry raisers have used for years. Illumination merely insures a steady yield, whereas the ultra-violet ray accelerates production.

Non-rot wood is now being made from saw-dust. Seed oysters are now being propagated in hatcheries—heretofore considered an impossibility. Florists have found a way to give perfume to odorless flowers. Slate is being incorporated into rubber to lengthen its life and increase its durability. High-grade potash is being obtained from sun-flower ash, the yield being upwards of 200 pounds to the acre of sun flowers. Artificial silk is being made from spruce wood and cotton waste. Sharks, formerly the most undesirable of deep-sea tenants, now contribute their skins for the manufacture of belts and bags, their oil for medicinal

purposes and their eyes for jewelry. Metallurgists have produced a new metal so hard it will turn a lathe, yet so porous it will absorb oil like a sponge. It will be used for installations that have heretofore lent themselves with difficulty to lubrication. Eucalyptus oil is now being made to produce a high-powered gasoline. Electric power is being generated from the wind, by means of wind-mills. Spider-webs are being cultivated in Europe where they are transferred to-gummed cards, treated chemically to harden and water-proof them, then used for trimming on women's hats. Delicate instruments now predetermine the occurrence of earthquakes, and scientists in Washington and South America have been predetermining the general trend of the weather, with considerable accuracy, two and three years in advance.

Are you wondering what all this has to do with your particular business? Such a list of facts could be continued over many pages. The few that are given are set down here to force home the realization that many of the recent developments effect us and our business—that in the interest of ourselves and our industry, we must keep abreast of the times.

Developments to Come.

However far we have progressed, past developments will be minor in comparison with the developments that are coming. By 1930 this country will be honey-combed with air-routes, and passenger, express and freight aerial service will have become an important factor in our commercial life. The privately owned freight planes now plying between Chicago and Dearborn are saving the Ford Motor Company \$1,000 a week in time and money. Such economies will immensely augment the demand for freight planes, and heavy demand brings large production and low prices. With low prices and the development of landing facilities will come wide adoption of the passenger plane.

There will be comparatively few gasoline-driven automobiles in the United States by 1950. At our present rate of consumption the oil reserves of this country will be largely exhausted in 12 to 14 years. At the same rate, we will exhaust the known reserves of the world in about 20 more years. Even now the high cost of gasoline is curbing the growth of the automotive industry in Europe and within a few years—10 or 15—we will see a like development here. The lack of an adequate supply of gasoline, however, will fail to stem the oncoming tide of motor vehicles. During the past ten years motor truck traffic has increased itself 100 times. While this rate will probably not continue the saturation point is a long way off. But the motor vehicles of the future will be electric or steam—power of a kind that has steadily decreased in production cost since the beginning. Electric trucks, with trailers, will become an increasingly important factor in transportation. Streets in metropolitan centers will be two and three level thoroughfares, and the paved roads of the country will be built to withstand much heavier traffic than is now allowable.

This is not imagination. Merely a few facts to set you right on what is coming and coming fast. Earnest cogitation, with a pencil and paper, will prove their accuracy. The transit commission of New York City estimates that the metropolitan area will house over 10,000,000 people by 1935—17,000,000 by 1960. At

(Concluded on page 51)

INSTALLATION SURVEYS

Getting the Most Heat Out of Fuel

A Wasteful Boiler Plant Starts Earning Dividends

A VERY large steel plant located on the Ohio River had never paid special attention to its steam plant; coal was plentiful and cheap, boiler-house labor was considered a minor item against the cost of a ton of steel, and there was a surplus of blast furnace gas for a considerable portion of the load.

Then conditions changed. Coal reached \$4 per ton, labor 48 cents per hour, and increasing electric load absorbed available excess blast furnace gas. Orders went out to economize—"get the maximum out of every ton of coal."

Getting the maximum amount of heat out of a given quantity of fuel really resolves itself into at least two separate and distinct problems, namely, obtaining maximum absorption efficiency and maximum combustion efficiency.

The absorption efficiency depends upon a great many factors which differ according to the type of process under consideration. In the case of a steam boiler, for example, the efficiency of the absorption of heat depends upon the design of the boiler and furnace, the type of baffling throughout the furnace passes and their condition of repair, the degree of cleanliness of the boiler heat absorbing surfaces, both inside and outside.

The combustion efficiency, on the contrary, is ordinarily not affected to any great extent by the original design of the heat absorbing apparatus or by its state of cleanliness, but is dependent primarily upon the relation of air supply to fuel supply and by the design of the grate.

The loss of heat up the chimney represents the greatest loss of all. In certain types of power and metallurgical processes this loss often amounts in regular operation to 50 per cent or more of the inherent heat of the fuel and under the most efficient conditions is seldom less than 15 per cent.

The chimney loss is in turn made up of several component losses, the greatest of which is almost invariably the sensible heat contained in the hot escaping gases. If the fuel is burned with more air than is required for complete combustion it is apparent that the excess air will not only reduce the temperature of the combustion chamber by its mere diluting effect, but will also increase the volume of the gases passing through the furnace to such an extent that their velocity will necessarily be increased, consequently giving them less time in which to give up their heat before escaping up the chimney. Fortunately the air supply can easily be proportioned for most efficient results by watching the percentage of CO₂ in the escaping flue gases and making adjust-

ments more or less frequently so that the most desirable percentage of CO₂ will result.

Recording CO₂ meters are the instruments which enable the operator to measure the relative weight or volume of the flue gases. The relation between the percentage of CO₂ and the volume of the products of combustion per pound of carbon consumed is clearly illustrated by Fig. 1. It will be seen, for example, that when the CO₂ in the products of combustion is 7 per cent, the amount of gases that must be heated up to stack temperature is three times as great as when the percentage of CO₂ is the theoretical maximum (viz. 21 per cent for carbon) and the heat lost up the chimney is in proportion, namely three times as great. It is therefore apparent that by reducing the quantity of the flue gases (increasing CO₂) as much as possible, as well as by reducing the temperature of these waste gases, the loss of heat up the chimney will be minimized.

However the temperature of the flue gases is a variable over which the furnace attendants have no control at all (being dependent upon the rate of driving the boiler, the cleanliness of the boiler heating surfaces and the condition of the baffles), whereas the quantity of flue gases per pound of fuel burned depends upon the air supply and is entirely within the control of the furnace attendant provided he is furnished with CO₂ recording equipment to guide him. Without such a guide the quantity of flue gas per pound of fuel is bound to vary within wide limits and to be in excessive amount a large part of the time.

EXAMPLE IN FUEL SAVINGS BY INCREASING CO₂

	Before	After
CO ₂	6¼%	10%
Chimney loss	30%	20%
All other losses	10%	10%
Total loss	40%	30%
Efficiency (100 - Total Loss)	60%	70%
Btu. per lb. of fuel	14,000	14,000
Btu. converted into steam per 1,000 lb. of fuel (1,000 x 14,000 x efficiency) ..	8,400,000	9,800,000
Relative weights of fuel to produce same amount of Steam		
1,000 x 14,000 x 60% =	1,000 lb.	857(+)lb.
8,400,000 Btu.		
857 x 14,000 x 70% =		
8,400,000 Btu.		
Saving in pounds per 1,000 lb. Fuel purchased		143 lb.
Saving in per cent		14.3%
Saving in dollars per \$1,000 spent for Fuel		\$143

CO₂ recorders were installed on each of the twelve boilers. The type selected was one of the several standard makes, any one of which falls well within the purchasing power of any operating department.

The total cost of instruments amounted to \$2,700, and the installation required three men's time for two weeks.

The net result of this first step in the campaign was as follows: CO₂ was raised, chimney loss reduced, efficiency increased 10 per cent, less coal was burned per hp. hour, and substantial savings were effected throughout the operation. These differences are shown in the two comparative tables shown:

From the above example it will be observed that, although the chimney loss is reduced only 10 per cent (that is from 30 to 20 per cent) by increasing the percentage of CO₂, the actual reduction in fuel consumed

amounts to 14.3 per cent, a cash saving of \$143 on every \$1,000 spent for fuel. It is not at all unusual to effect savings much greater than those cited above, merely by increasing the percentage of CO₂, since in practice, coal burning plants can often increase CO₂ to 14 per cent or 15 per cent with the aid of CO₂ recorders.

When the further fact is known that the plant under discussion operates 10,000 hp. of boilers with a coal requirement (originally) of over 21,000 tons per year, the extent of the saving made by the simple, reliable and inexpensive CO₂ recorders can be readily estimated.

Material Handling Costs Money

Trutractor Replaces Six Men and Saves \$2,959.60 per Year

STEEL tanks, blast furnaces, gas boilers, towers, barges, and all kinds of structural steel are manufactured by the Riter-Conley Manufacturing Company, at Leetsdale, Pa. They have two main shops and a galvanizing plant, and a large amount of trucking is necessary within each shop and between shops.

In choosing interior trucking equipment, the effect on labor turnover should receive serious consideration. Hand trucking is hard work at best, and few men will do it very long. It not only involves heavy expense due to high turnover, but it also renders labor troubles more serious because of the large number of men required.

The Riter-Conley Manufacturing Co. killed several birds with one stone when they installed two Clark Trutractors to handle their interior and inter-plant hauling. The work has been made so much easier and more pleasant that labor turnover among truckers has dropped from several hundred per cent to practically nothing. At the same time, the reduction in laborers decreases labor troubles.

The material is loaded on buggies with cranes and the buggies pushed around the plant wherever needed by means of Clark Trutractors. Because of the nature of the product these loads are often very heavy, ranging from 2 tons to 20 or 30 tons. A short time ago one trutractor pushed a load of 65 tons.

Repeat Order Placed for Clark Trutractor.

The first trutractor was bought about three months ago. This one is used in No. 2 Shop where there were large numbers of punching and riveting machines. The other trutractor was bought a week ago, for use in Shop No. 1, where rivets are made, all machine shop work done, and all plate work fabricated.

The trutractor in Shop No. 2 is used for transferring materials, tools, etc., within the shop and back and forth between this shop and the machine shop. It also carries rivets and other materials between the shops and the galvanizing plant. All of this work is

now handled by the trutractor, but it has not yet reached its maximum capacity. If necessary, it could handle several times the amount of work now done.

Costs Only \$1.85 a Day.

The cost of operating the trutractor is quite small. Including depreciation, average interest, maintenance and repairs, gasoline, oil, and the wages of a driver and two loaders, the cost amounts to \$14.20 a day. The operating cost of the trutractor without the two loaders, is \$6.60 a day, and without driver or loaders, it is only \$1.85 a day. Considering the amount of this work handled in this shop, these costs are very reasonable.

Before the Clark Trutractor was installed, all of this work was done by hand and it was difficult to get it done satisfactorily. Sometimes it was necessary to work overtime with a large crew in order to keep the floor cleared. There were regularly from 3 to 5 men and a leader doing the work. However, it was often necessary to get help from other sources around the shop. This was costly and inconvenient.

Saves Waiting for Motor Truck.

The hauling between the shops and to the galvanizing plant was handled by means of a large auto truck. The material was carried on buggies to the yard and there loaded onto the truck. This was only a part of the work done by the truck and accordingly it was not always available when needed. It was often necessary to wait or get parts from the machine shop with wheelbarrows when needed in a hurry.

Practically all of this work is now readily handled by means of one Clark Trutractor which is capable of doing considerably more than is required at present. The trutractor can handle any size load without manual assistance. It is an easy matter to get men to do this work in conjunction with the trutractor and to keep them on the job. Without the trutractor, the work was so hard that it was almost impossible to keep the men and it was hardest during busy times, when they were needed the most.

Improves Work Throughout Entire Shop.

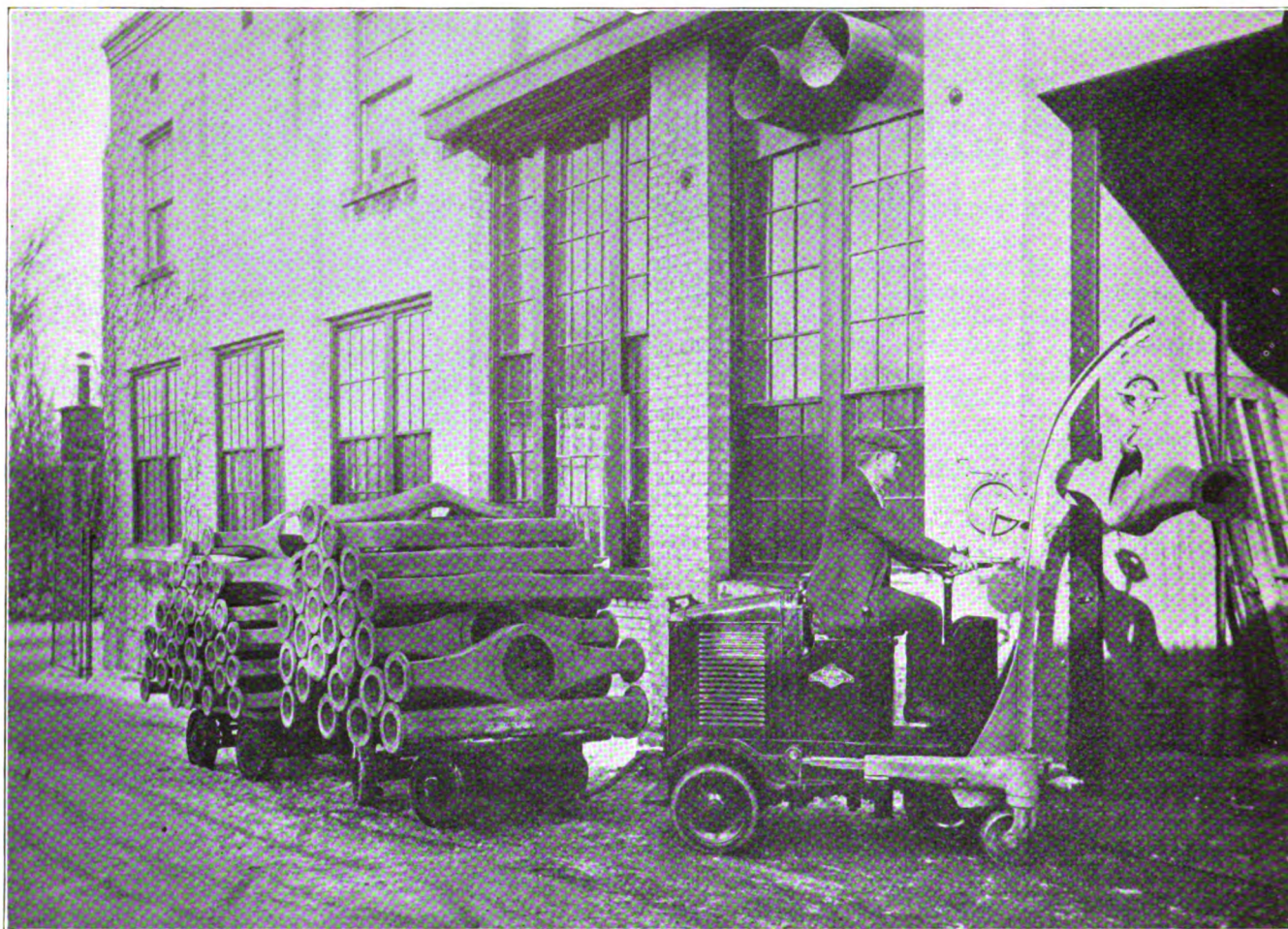
It is difficult to determine accurately all of the savings effected by the Clark Trutractors. The cost

of doing the work by hand, including only the costs of the labor and the auto truck, without considering other indirect costs, averaged about \$24.77 a day. As the cost of doing this work with the tructractor amounts to only \$14.20 a day, there is a direct saving of \$10.57 a day. In a year this amounts to \$2,959.60 and will pay for the tructractor in less than seven months.

There are other advantages and savings derived from the use of the tructractor. One of these may be relatively large. This is the improvement of the

labor turnover on this work has been reduced from several hundred per cent to practically nothing, and the tructractor with its small crew is always on the job and ready to do the work. It never gets tired or run down and can push just as many and just as heavy loads at the end of the day as at the start.

The three wheeled construction of the Clark Tructractor is very valuable in this plant because of the short turning radius which this gives and the ease and speed with which it can be handled in the aisles. Since the first tructractor was installed and put in



A very interesting development wherein gasoline tractor is combined to effect several combinations. A Clark Duat carrying steel casting on crane, while towing two trailers which were loaded by the crane.

work in the shop made possible by easy and quick transferring of the material. This is, of course, most important when the shop is the busiest. In fairly busy times, speedy transferring by the tructractor saves an appreciable amount of time all over the shop as compared with transferring by hand. It is reasonable to say that this saving would average at least 5 to 10 minutes a day during busy periods. At such times the tructractor would pay for itself in 54 to 80 working days.

Labor Turnover Reduced from Several Hundred Per cent to Practically Nothing.

One of the most important advantages of the Clark Tructractor is its ability to reduce the number of laborers required and make the work easier. The

working shape, it has given no trouble whatever. The Clark Tructractor Company gave us good and very prompt service at the time each tructractor was bought.

DIRECT SAVINGS EFFECTED BY CLARK TRUCTRATOR

Labor—6 men $\times$ $9\frac{1}{2}$ hrs. $\times$ \$.40.....	\$ 22.80
Truck— $\frac{3}{4}$ hr.— $\frac{25.00}{9.5 \text{ hrs.}}$	1.97
Total cost per day—hand method.....	\$ 24.77
Cost per day—Tructractor method.....	14.20
Direct saving per day.....	\$ 10.57
Saving per year—\$10.57 $\times$ 280.....	\$2,959.60

The tructractor pays for itself in less than 7 months due to this saving.

Combustion Control System Reduces Labor

It Saved \$4,359.04 a Year in Wages, and Also Increased the Boiler Efficiency Appreciably

WHEREVER the load on a boiler fluctuates rapidly over an appreciable range, an automatic system of combustion control is practically essential to good operation. Between three and four years ago the demand on this gas generating plant began to increase. A new 308 hp. Heine coal burning stoker-fired boiler was then installed to supply the growing demand for steam required by the water gas generator.

The new boiler supplemented two old boilers, one of which was tar-fired and the other coal-fired. After this boiler had been operated but a few months, it became apparent that with the constantly increasing load some automatic means of controlling the fuel and air supply to this boiler would have to be provided. With the load fluctuating from 100 per cent of rating up to twice the normal value in but a few minutes, it was evident that to try to follow this varia-

SAVINGS EFFECTED BY COMBUSTION CONTROL SYSTEM

Binghamton Gas Works Company

Labor saving per shift—8 hours x 56c.....		\$ 4.48
Labor saving per day during 8 months of the year	3 x \$4.48	13.44
Labor saving per day during 4 months of the year	2 x 4.48	8.96
Labor saving per year—243 days x \$13.44—\$3,265.92		
122 days x 8.96—1,093.12		
Total saving in labor per year.....		4,359.04

tion by hand regulation was very poor practice. After making an investigation of the features of several combustion control systems, it was decided to install a standard (size 2½) master regulator. This device varies the speed of the stoker, speed of the forced draft fan, and the position of the damper in the flue. In addition to this there was constructed a contrivance of company invention by which the master regulator varies the fuel supply to the tar burners on one of the old boilers.

The two old boilers are used only when the new one is down for cleaning purposes. At such times one of them is operated at a constant rating and the other, on which the regulator controls the fuel supply to the burners, supplies the intermittent load. This system has been found to be an excellent means of controlling the amount of fuel burned in accordance with the demand for steam. It has effected a considerable saving in labor.

This plant supplies gas to the entire city of Binghamton, N. Y. The output in 24 hours runs up to nearly 2,000,000 cu. ft. A water gas generator is used and is operated on 7-minute cycles. At the beginning of a cycle the amount of steam forced through the incandescent coal runs the demand on the boiler up to about 125 per cent of rating for 2½ minutes. Then the demand runs up to 175 per cent for 1½ minutes. During the last 3 minutes of the cycle the steam load is increased still further and forces the boiler to 200 per cent of rating. At the

end of this 3 minute period the supply valve is shut off and the load drops to 100 percent of the boiler rating almost instantly.

Steam is generated at 125 pounds pressure, and is superheated 50 deg. to 75 deg. F. with superheaters. A chain grate stoker driven by a variable speed steam engine is used on the coal-fired boiler. A valve regulated with a wire cable from the master regulator varies the steam supply to this engine according to the steam pressure in the heater. Any drop in pressure will cause the master regulator to open the valve further, admitting steam to the engine driving the stoker, and vice versa.

There are two steam pipes leading to the regulator. One of these is tapped on the main steam supply line and the other on the superheater. Valves are inserted so that the system can be controlled from the pressure in the superheater or from the main line.

Another cable from the regulator operates a valve controlling the steam admitted to the turbine driving the forced draft fan for this boiler. This fan is rated at 1,400 cu. ft. per minute. The turbine and fan are installed about 60 ft. from the master regulator.

A third cable from the master regulator leads to the damper in the flue at the rear of the furnace. The fourth cable leads to the system of levers which control the tar supply to one of the old boilers.

In addition to being used for the manufacture of gas, the steam is used to drive a number of auxiliary units such as reciprocating steam pumps. Also, all of the centrifugal fans used in conveying the gas in the processes and to the large container tanks are driven by steam turbines.

The plant is well equipped to keep a good check on the boilers. An integrating and recording steam flow meter is used to measure the steam output of the boiler. Feed water regulation is automatic. A steam pressure recording meter is used also. These charts show a very smooth steam pressure line, but with the hand system of regulation the fluctuations in steam pressure are decidedly more. The fluctuations with the automatic control are only 3 or 4 lb. from the normal value.

If it were not for the regulator and it was necessary to return to the old system of hand regulation, the present load conditions would require an additional man in the boiler room for each shift. Practically all of one man's time would be taken up controlling the stoker speed and the air supply to the boiler for the varying loads. Another man, with the aid of a larry car traveling on a monorail overhead crane, would have to take the coal to the hopper above the stoker. Thus, there is a labor saving amounting to \$4.48 per shift.

The additional man would be needed on each of the three 8-hr. shifts for an average of eight months a year. For the remainder of the year, during the warmer summer months, an extra man would be required for two shifts in 24 hrs. The total saving due to this installation amounts to \$4,359.04 per year.

Babcock & Wilcox—Fuller-Lehigh

The Babcock & Wilcox Company announces that it has purchased the Fuller-Lehigh Company and its subsidiaries, manufacturers of pulverized fuel and cement mill equipment; also that it has purchased the Bailey Meter Company, manufacturers of meters and recorders, combustion control equipment, pulverized fuel feeders, and water cooled furnace walls. The Fuller-Lehigh Company and the Bailey Meter Company will be operated with the same organizations as heretofore, with the exception that Col. J. W. Fuller will become chairman of the board of the Fuller-Lehigh Company, Mr. E. G. Bailey will become president, and Mr. A. E. Douglass of Fuller-Lehigh Company will become vice president in charge of sales. Mr. Bailey will continue to act as president of the Bailey Meter Company, and Mr. R. S. Coffin will continue as vice president and general manager.

By the acquisition of these companies the Babcock & Wilcox Company will be able to offer boilers, superheaters, chain grate stokers, oil burners, pulverized fuel equipment, water cooled furnace walls, meters, and combustion control equipment, all in any combination that may be required to supply complete steam generating units.

Tests of Small Furnaces

The relative thermal efficiency and the economy in the use of the available fuels in domestic furnaces is of great interest to all householders; also a knowledge of the design or arrangement of the furnace best suited to each fuel is necessary. Investigations have been conducted by the Bureau of Mines on the burning of anthracite and bituminous coals, coke, and natural gas in a small furnace in which the amount and arrangement of heating surfaces could be varied. This work has been done in co-operation with the laboratory of the American Society of Heating and Ventilating Engineers. It has included a close study of the process of combustion, particularly for bituminous coal. Small furnaces, it is pointed out, tend to permit the smoke and tars from this fuel to pass into the chimney unconsumed due to the comparatively low temperatures and short gas travel pertaining, and thus reduce the efficiency and contribute to the smoke nuisance.

Genuine Open-Hearth Iron

(Continued from page 36)

To further stimulate an interest and to help in extending the movement a magazine was started, which appears six times a year. The magazine is published by the Foremen's Publishing Company, Inc., at Dayton, Ohio.

For the past two years annual conventions have been held by the Federation of Foremen's Clubs at Dayton, Ohio. At these conventions, which have been attended by 1,200 to 1,500 men, men of national prominence have come to talk to the men, bringing to them the larger point of view of the outside business world.

Next year the first convention of the National Association of Foremen will be held at Springfield,

Ohio, and even more elaborate plans are being made to stimulate the movement.

The Foremen's Club movement has been planned close to the Y. M. C. A. and the relation existing between the Foremen's Clubs and the Y. M. C. A. has been very friendly and very helpful.

The Foremen's Clubs must be held on a high moral plane, and the Association with the Y. M. C. A. helps to do this. The two are knit sufficiently close together so that in the organization of the National Association of Foremen one of the Directors represents the National body of the Y. M. C. A.

At the Newport Rolling Mill Company and The Andrews Steel Company, the Foremen have taken great interest in the Foremen's Club, and during the life of the Cincinnati Foremen's Club the Presidency and one member of the Board of Control has been chosen from these two companies. The officials of the Company, and practically all of the Foremen are members, a total of 178.

In this connection it was made possible for the rollers, who are responsible for the men on their crew, and who really fill the position of Foreman, to become members of the Club. The men attend the meetings regularly whenever they are on a turn which allows them to do so, and they get stimulation from the talks which they hear.

There has been a pronounced improvement in the co-operation existing between departments since the men have realized the value of co-operation in an industry. They have taken great interest in the Foremen's Training side of the movement, and in addition many are attending night courses offered in the Cincinnati institutions.

The general affect of the Foremen's movement on the supervision of those companies has been very satisfying.

The Community House.

The Westside Savings Bank opened for business last May in the community house maintained by the Andrews Steel Company and the Newport Rolling Mill Company. The majority of the Board of Directors are all mill employees or officials and the stock holders are all mill employees. The bank is in a very flourishing condition and it is expected that within a short time that it will be one of the strongest banks in this section. Every week after payday they receive on savings accounts, \$3,000 to \$5,000.

In conclusion, reference to the ideals upon which this organization has been founded and grown may perhaps be timely.

G. O. H. I., pronounced "Go-Hi" is the trademark and name under which these products are known. Gohi expresses the best; it is short for Genuine Open Hearth Iron, which contains in impurities: Carbon, Sulphur, Manganese, Phosphorus and Silicon, a total of only .035 of 1 per cent to .125 of 1 per cent, as against the impurity content of steel of about 10-times these amounts.

This product is absolutely uniform in quality and having so low an average impurity content, resists rust and corrosion to a marked degree.

According to metallurgical theory this pure iron copper alloy approximates the ideal rust resisting metal. It is around such an ideal that Newport has prospered.

Review of Iron and Steel Literature for 1925

A Classified List of the More Important Books, Serials and Trade Publications During the Year, with a Few of Earlier Date, Not Previously Announced

By E. H. McCLELLAND*

THIS list constitutes the ninth annual review of iron and steel literature compiled for THE BLAST FURNACE AND STEEL PLANT. An attempt has been made to list the more important publications of 1925, together with certain publications dated 1924 but not available for inclusion in the list compiled near the end of that year.

Where possible, the compiler has examined the publications listed, but in some cases the publications were not accessible and the only information regarding them was in technical journals and publishers' lists, which, unfortunately, are not always either accurate or complete. Prices are sometimes particularly hard to verify promptly, certain sources of information occasionally differing very widely. The prices here given are, therefore, probably in some cases incorrect. German prices, quoted in marks, refer to the "goldmark," equivalent to 10/42 of a dollar.

One of the most important publications of the year is the "Metallurgist," issued monthly as a supplement to the "Engineer" (33 Norfolk St., Strand, London, W. C. 2). In the first issue (January 30, 1925), the scope and purpose are outlined as follows: "For one thing, we shall not be tied down by any hard-and-fast limitations, such as the often arbitrary distinction between ferrous and non-ferrous metallurgy, or between the older branches of metallurgy and the modern developments sometimes classified as 'metallography.' The whole field of knowledge and experience relating to metals and their properties and uses is open to us, and we would particularly emphasize the fact that it will be our aim to hold as even a balance as possible between the more scientific aspects of the subject and its practical side. . . . It is not proposed to fill these Supplements with the outpourings of a staff of technical workers and experts in their subjects. None the less, in addition to original matter describing work done or experience gained, we hope to provide articles of a more general kind such as could not find space in a technical 'journal,' but should, none the less, be welcome and interesting to our readers, whether engineers or metallurgists. Summaries of existing states of knowledge or opinion on various metallurgical subjects, critical descriptions of processes and products and of methods of using them, written with full knowledge and complete independence of view, should serve this purpose."

Some of the most important publications are the work of Pittsburgh authors. The fourth edition of "Making, Shaping and Treating of Steel," by Camp and Francis, and the new volume of "Industrial Furnaces," by Trinks, stand unrivaled in their respective fields; while a new book on corrosion, the work of a Pittsburgh metallurgist, is now in press and will appear early in 1926.

GENERAL

Geology, Ores, Mining.

Hallimond, A. F., and others. Iron Ores; Bedded Ores of England and Wales, Petrography and Chemistry. 139 pp. 1925. H. M. Stationery Office, London. 3 sh.

*Technology Librarian, Carnegie Library of Pittsburgh.

(Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain, vol. 29.)

Kukuk, Paul. Deutschlands Kohlen-, Kali- und Eisenlagerstätten. Ed. 4. 1924. Georg Westermann, Brunswick. 5 m.

Littlefield, M. S. Preliminary Report of an Investigation of the Molding Sand Resources of Illinois. 37 pp. 1925. Urbana, Ill. (Report of Investigations, No. 3.)

Investigation by Illinois Geological Survey in co-operation with Engineering Experiment Station of University of Illinois.

Ontario—Department of Mines. Report of the Ontario Iron Ore Committee with Appendix. 306 pp. 1924. Toronto.

Pickands, Mather & Company. Analyses, Lake Superior Iron Ores. 19 pp. 1925. Cleveland.

Metallurgy, Testing.

Backert, A. O., ed. A B C of Iron and Steel with a Directory of the Iron and Steel Works and Their Products of the United States and Canada. Ed. 5. 415 pp. 1925. Penton Publishing Co., Cleveland. \$6.

Camp, J. M., and Francis, C. B. The Making, Shaping and Treating of Steel. Ed. 4. 1142 pp. 1925. Carnegie Steel Co., Pittsburgh. \$7.50.

The best and most comprehensive work now available in any language.

Empire Mining and Metallurgical Congress, London, 1924. Proceedings. Part 4: Metallurgy of Iron and Steel. 296 pp. 1925. 10 sh. 6 d.

The entire "Proceedings" consists of five parts, including also general report, mining, petroleum, and non-ferrous metallurgy.

Folkerts, H. Die Windführung beim Konverterfrischprozess. 160 pp. 1924. Julius Springer, Berlin. 14.10 m.

Gathmann, E., and Dornin, G. A. Unsoundness in Steel, and Fundamentals Essential to Soundness. Ed. 2. 1924. Gathmann Engineering Co., Baltimore.

Gillett, H. W., and Mack, E. L. Molybdenum, Cerium and Related Alloy Steels. 299 pp. 1925. Chemical Catalog Co., Inc., New York. \$4.

Deals briefly with effects of other alloying elements, but is chiefly a record of experimental work designed to afford information regarding the influence of molybdenum on endurance and impact properties, and on the properties of "transverse" specimens.

Greaves, Richard Henry, and Wrighton, Harold. Practical Microscopical Metallography. 125 pp. 1924. Chapman & Hall, Ltd., London. 16 sh.

Hadfield, Robert A. Metallurgy and Its Influence on Modern Progress; Being an Address Delivered before the Oxford University Junior Scientific Club. 189 pp. 1925. Chapman & Hall, London.

Heindlhofer, K. Crystal Structure of Hard Steel. Author, Philadelphia.

Thesis for Ph.D. at University of Pennsylvania.

Hermanns, Hubert. Bau und Betrieb Moderner Konverterstahlwerke und Kleinbessemerieen. 251 pp. 1925. W. Knapp, Halle a S., Germany. 13.50 m.

Iron and Steel Institute. Carnegie Scholarship Memoirs. Vol. 14, 186 pp. 1925. The Institute, London.

Iron and Steel Institute. Journal. Vol. 110, 531 pp. 1924; vol. 111, 675 pp. 1925. The Institute, London.

Jones, J. A. Tungsten Steels. H. M. Stationery Office, London. 4 sh. (Research Department, Woolwich. Report 65.)

Karnaukhov, M. M. [Metallurgy of Steel.] 2 vol. 1925. Leningrad.

In Russian. Vol. 1 (254 pp.) deals with Bessemer and Thomas processes; vol. 2 (226 pp.) with Martin process and combination processes.

Müller, Wilhelm, and Donauer, Max. Das Buch der Eisenkunde (Eisen, Röhren, Bleche, Metalle). 594 pp. 1925. G. D. Baedeker, Essen. 16 m.

Oberhoffer, Paul. Das technische Eisen; Konstitution und Eigenschaften. Ed. 2. 598 pp. 1925. Julius Springer, Berlin. 31.50 m.

Revision of "Das schmiedbare Eisen."

Pavloff, M. Determination of Dimensions; Blast-Furnaces and Open-Hearth Furnaces. 148 pp. 1925. Leningrad.

In Russian.

Pila. Allgemeines Profilverzeichnis der deutschen Eisenwalzwerke. Ed. 3. 218 pp. 1924. Otto Hammerschmidt, Hagen i. W. 20 m.

Pitois, E. L'Essai aux étincelles; ce que toute personne utilisant l'acier doit connaître et peut appliquer. 32 pp. 1924. Ch. Delagrave, Paris. 10 fr.

Rapatz, F. Die Edelmstähe. 219 pp. 1925. Julius Springer, Berlin. 12 m.

Technical information on high-grade, or "super-steel."

Schwarz, M. von. Eisenhüttenkunde. Vol. 1: Das Roheisen. 128 pp. 1924. Walter de Gruyter & Co., Berlin. 35 cents.

Staffordshire Iron and Steel Institute. Proceedings. Session 1923-24. Vol. 39, 167 pp. St. James Road, Dudley, England.

Van Dyke, G. Shop Handbook on Tool Steel. 80 pp. 1925. Joseph T. Ryerson & Son, Inc., Chicago.

Non-technical pamphlet on practical treatment of tool steel. Special attention to Ryerson products.

Economics, Statistics, Directories, History.

American Iron and Steel Institute. Annual Statistical Report for 1924. 102 pp. 1925. The Institute, New York.

Statistics of production, prices, imports, and exports. Includes United States and Canada.

Andresen Company, Inc. Directory Giving List of Companies and Officials Operating Blast Furnaces, Steel Plants, Rolling Mills, By-Product Coking Plants, Structural Steel, Boiler and Tanks, Railroad Shops, Forging, Heat Treating and Stamping Plants in the United States and Canada. 358 pp. 1925. Pittsburgh. \$10.

Burchard, Ernest F., and Davis, H. W. Iron Ore, Pig Iron and Steel in 1923. Published January 22, 1925. Government Printing Office, Washington, D. C.

Advance publication of pp. 295-329 of the United States Geological Survey's "Mineral Resources of the United States, 1923," Part 1.

Dochner, O. H. Geschichte der Eisendrahtindustrie. 113 pp. 1925. Julius Springer, Berlin. 12 m.

Firth (Thomas) & Sons, Ltd. History of a Great Steel Manufacturing Firm. [1924.] Sheffield.

Cover title reads "Firth's Steel."

Illustrated pamphlet, without paging, showing processes in steel manufacture.

Greiling, Walter. German Iron and Steel Industry. 20 pp. London and Cambridge Economic Service, London. 5 sh.

Johannsen, Otto. Geschichte des Eisens. Ed. 2. 248 pp. 1925. Verlag Stahleisen, Düsseldorf. 20 m.

Mackintosh-Hemphill Company. 1803-1924; Over One Hundred and Twenty Years of Service. 36 pp. 1924. The Company, Pittsburgh.

Pioneer and recent work in designing and building rolling-mill machinery.

Margrie, W. Coal and Iron; an Essay and a Drama Dealing with the Industrial Crisis. 32 pp. Watts & Co., London. 1 sh.

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Vision—Prime Essential for 1926

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that time more than seven millions will be forced to use suburban service at least twice daily. Thoughtful students of industrial trends and commercial development do not hesitate to say that Chicago will surpass New York City in population and commercial importance within the next 50 years. The development of the St. Lawrence waterway, the opening of the canals to the Gulf, and the development of aerial transportation, all afford certain foundation for the foregoing prophecies.

By 1950 the population of the United States will be, according to the most conservative estimates, about 150,000,000. To care for that number in the matter of food and clothing alone, we must greatly increase the attraction to agriculture. Radio, automobiles, paved roads and airplanes will do this. In the matter of transportation, we must have more than fifty per cent greater facilities since demand increases out of proportion to population.

One cannot contemplate the increases in population, the changes in commercial activity, or the tremendously augmented demand for all commodities, without realizing that with them must come added responsibilities and the development of far-reaching improvements. Hence the assertion that the prophecies made here are in no wise fancy. Rather, the few that are given have been based on the conclusions and convictions of the most thoughtful and most conservative observers.

At no time in history has there been greater need for the exercise of foresight with respect to coming changes. People who are self-sufficient, who do not keep abreast of the times because of the delusion that they have the world by the tail, will likely find themselves occupying an exceedingly precarious position in the early tomorrow. Never before has it been so necessary to maintain vigilance over what is going on in the fields of science and research. Political intrigue, racial misunderstandings, and unsound national ambitions cannot continue against the forces of engineering and science. In like measure, "glorious isolation" in business is as much a something of the past as the old pick and shovel. Through engineering and science there has been developed a bond of direct relationship between every industry—between every enterprise. In the manufacture of such wholly different products as ink, condensed milk, cement, salad dressing, nitroglycerin and sugar, several identical engineering chemical processes are used. Hence it is, the welfare of one effects the welfare of all.

In the past developments of far-reaching importance came about slowly enough to permit of easy adjustment. Today they rise with startling rapidity, and unless we keep abreast of the trend we will be forced into the positions afforded followers. "Where there is no vision people perish" contains more truth today than when written. Vision—is the prime essential for 1926.

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Oil-Electric Locomotives and Their Industrial Possibilities

The Test Data Contained Offers Comparisons with Present Practices in Steel Mill Shifting

By S. T. DODD*

A NEW source of power for railroads has come prominently to the fore with the introduction of the oil-electric switching locomotive. Following a series of exacting tests on numerous railroads, this type of engine has been introduced on seven railroads, six of them entering New York City. The Central Railroad of New Jersey, the Baltimore and Ohio, the Lehigh Valley, the Delaware, Lackawanna & Western, and the Erie have each obtained 60-ton units for switching service, and the Long Island Railroad has obtained a 100-ton unit for the same type of service. A 60-ton locomotive has also been obtained by the Chicago & Northwestern Railway for service in Chicago.

It is not only to the railroad themselves that the oil-electric locomotive appeals; it is fully as important an addition to industrial railroads.

Briefly, the locomotive is one in which an internal combustion oil engine, using low grade fuel oil, drives an electric generator which furnishes power to electric motors geared to the axles of the driving wheels. Its advantages are much more economical and speedier operation, and absence of noise and smoke. The locomotive is a joint development of the American Locomotive, Ingersoll-Rand and General Electric Companies.

In locations where complete electrification is not advisable, due to infrequency of traffic or other causes, the oil-electric locomotive presents features of low cost of operation and maintenance, ease of manipulation, and saving of time lost in refueling which hitherto have not been available except with the electric locomotive.

Details of Construction.

Two sizes of the oil-electric locomotive have been built; the first weighs 60 tons, and the second 100 tons. Both of the present units are primarily intended for switching and industrial service, but the design has no limits in power or speed. Plans have been drawn for the construction of a 3,000-hp. oil-electric locomotive—closely approaching the maximum power of the most powerful modern steam engine.

The 60-ton locomotive has a steel, box-type cab, carried on two, two-axle swivel trucks. It is equipped with a 300-hp. oil engine, direct connected to a d.c. generator which furnishes power for four d.c., geared traction motors mounted on the trucks. The dimensions are:

Length	32 ft., 6 in.
Height	13 ft., 9½ in.
Width	10 ft.
Total wheel base.....	24 ft., 2 in.
Rigid wheel base.....	7 ft., 2 in.
Minimum radius of curvature.....	90 ft.
Weight	120,000 lbs. all on drivers
Maximum speed.....	30 miles per hour

*Railway Engineering Department, General Electric Company, Schenectady, N. Y.

The cab is divided into three compartments. The central compartment contains the power plant and control apparatus, while the two end compartments are reserved for the operator. Doors are located to give access to each operator's compartment from the outside and to the central compartment from the operator's compartments. A hatch is provided in the roof of the central compartment directly above the oil engine to permit its removal. A smaller hatch is provided in the main hatch to facilitate inspection, minor repairs and adjustment of pistons and cylinder heads.

The Oil Engine.

The oil engine is of the six-cylinder, vertical, single acting type with direct oil injection, operating on a four stroke cycle. It was developed by the Ingersoll-Rand Company solely for railroad locomotive service.

The engine pistons are 10 in. in diameter, and have a 12-in. stroke. It develops 300 horsepower at 600 rpm. Fuel oil consumption, using oil containing 19,000 Btu. per lb., does not exceed .43 lbs. per bhp. hour.

Engine equipment includes a self-contained, complete lubricating system with direct-attached oil circulating pump, a water circulating pump direct-connected to the engine for circulating cooling water to cylinders and heads, and an air compressor direct-connected to the engine to automatically keep the starting air-bottles charged.

Fuel is injected in a direct spray by means of a pressure pump driven from the main shaft of the engine. No high pressure air is required for the injection; this eliminates the need for auxiliary two-stage air compressors with their high pressure lines and storage bottles. The combustion chamber design is unique in the arrangement of the fuel injection nozzles, two opposed nozzles being provided for each cylinder. These nozzles direct the sprays of oil in such a manner that they come together at the same time the air in the cylinder, driven up by the piston, is directed to the center of the impact of the sprays. Such an arrangement results in completeness of vaporization.

The engine is started by air pressure, admitted to the cylinders through a single control valve located in either operator's compartment. Shutting down is equally simple, and is accomplished by fully closing the locomotive throttle lever from either operator's position.

The Generator.

The electric generator, specially designed for this service by the General Electric Company, is a 600-rpm., 600-volt, d.c. unit, of capacity suitable for transmitting the full output of the engine. It is direct-connected to the oil engine. A 60-volt exciter is mounted on the same shaft as the main generator, and serves to excite the field windings of the main generator.

A 32-volt storage battery excites the fields of this exciter at low speeds, and is charged by the exciter at normal engine speeds. The main generator is so differentially compounded that the voltage is approximately inversely proportioned to the tractive effort.

The Traction Motors.

There are four-d.c., HM-840 series motors of the single geared, commutating pole type. Each is supported on its axle by axle brackets and bearings, and on the truck transom by a spring support. They have roller bearings at the pinion end, and ball bearings

The speed of the locomotive can be varied by changing the throttle. During acceleration the locomotive automatically accelerates at a rate determined by this throttle setting, and without loss of power in a rheostat.

Other Equipment.

Schedule EL-14 straight and automatic air brake equipment is provided. The main reservoir for the air have a capacity of approximately 45,000 cu. in.

A type CP-26 air compressor, which will deliver air at a pressure of 90 or 140 lbs. per sq. in. is

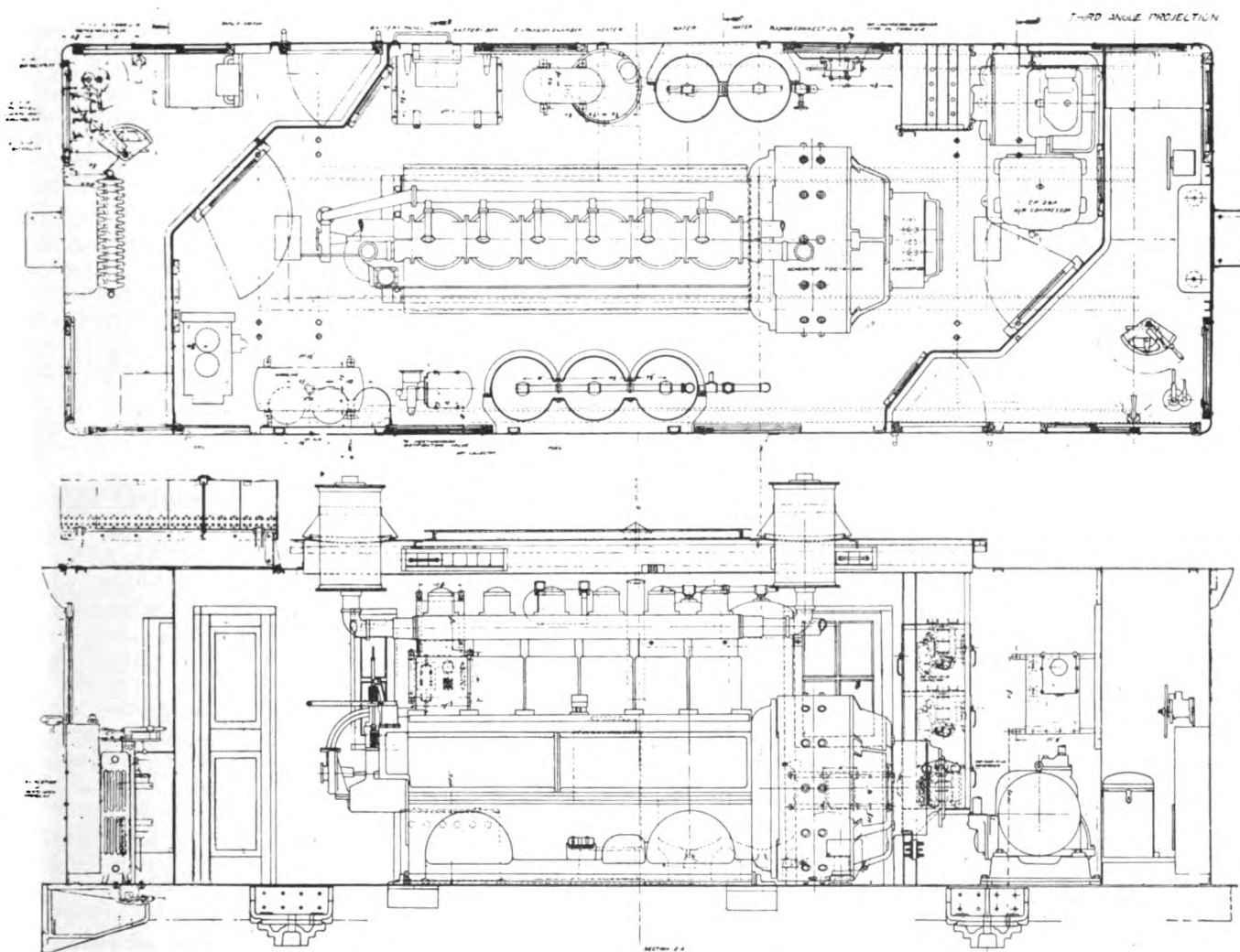


FIG. 1—Two drawings of the oil-electric locomotive. Upper showing plan view; lower view, elevation.

at the commutator end. The gear ratio is 5.86, with 82 teeth on the gear and 14 on the pinion. The nominal A.I.E.E. rating of the traction motor equipment is 95 hp. each, or 380 hp. for the locomotive.

Control Equipment.

The control, remarkably simple, consists of a reverse switch, series parallel switch, and throttle lever. The speed of the engine, and therefore its power, is controlled by the throttle lever which is similar to the throttle control of a steam engine. Opening the throttle by moving the lever increases the engine speed from idling to full speed within the limits set by the overspeed governor. The compounding of the generator field adjusts the output of the generator to correspond to the power set by the throttle opening.

provided in the cab.

There are a Mianus two-cycle gasoline-engine-driven air compressor and three high pressure air storage tanks to be used for starting the oil engine; a Peter-Smith type No. 1-C water heater and expansion chamber to keep the cooling water from freezing when the engine is not operating and for heating the operator's compartments, and two fin-tube type radiators of 1,200 sq. ft. total surface on the roof for cooling the water from the engine. In the cab there are two water tanks into which the water may be drained from the radiators in the winter when the locomotive is idle. The oil engine is provided with two exhaust pipes and mufflers. Fuel oil tanks total 200 gallons in capacity.

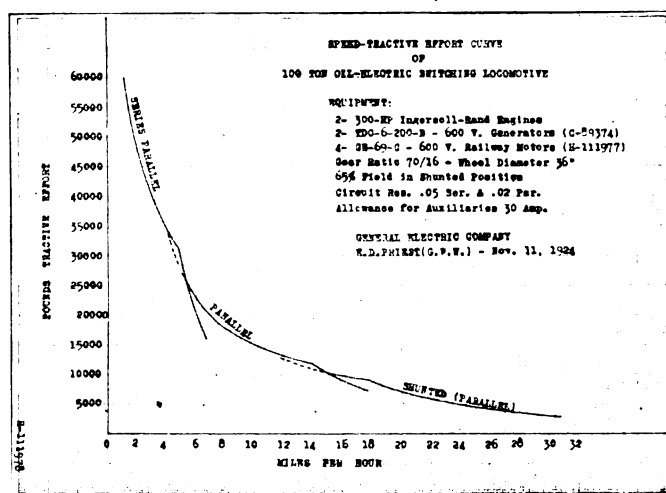
There are a 32-volt, 100 amp.-hr. Exide-Ironclad storage battery for lighting and control, a steel tool box with special tools, air-operated sanders, an air-and rope-operated bell, air-operated whistle, illuminated operator's gages, an integrating watt-hour meter to record the output of the generator, incandescent type headlights, and hot water radiators working from the oil engine circulating system and from the Peter-Smith water heater for heating the operator's compartments.

The 100-Ton Locomotive.

The 100-ton oil-electric locomotive is similar to the 60-ton unit except that it has increased dimensions and a power plant consisting of two oil-engine driven generator sets. The length is 45 ft. 2 in., and the total wheel base 36 ft., 2 in. The oil engines and electric generators have the same ratings as those in the 60-ton engine but the motors are, of course, larger. The motors, GE-69, have a nominal A.I.E.E. rating of 200 hp each at 600 volts, or a total of 800 hp. for the locomotive.

Oil-Electric Advantages.

Previous to the sale of any oil-electric locomotives, they were tried out in actual switching service on



numerous railroads, and accurate check kept on their operation. One of the locomotives was in switching service for 68 days, part of the time in 24-hour shifts, giving 833 hours of actual duty in this time. Fuel consumption was 2,400 gallons, or less than 15 cents per hour of locomotive service. The cost of operation, for fuel oil, lubricating oil and miscellaneous supplies, was \$247.85, or \$.297 per hour of locomotive service. A 60-ton locomotive, after two years in switching service, showed no appreciable wear on the oil engine parts, and no replacements were necessary.

The oil-electric locomotive has many of the operating advantages of the electric locomotive, with ease of manipulation and positive control. It not only speeds up yard movements but it eliminates time lost for taking on fuel and water since the fuel capacity of the oil-electric locomotive is sufficient to last several days.

Electric drive protects the engine from shocks to which it would be subjected with direct mechanical transmission, and its steady even pull reduces the shocks of switching and consequent damage to cars.

Long Island Railroad Service Tests.

The Long Island Railroad, which has since obtained a 100-ton oil-electric locomotive for switching service, made a test of oil-electric and steam locomotives employed in identically the same service. A 60-ton oil-electric and a class B-53-A saturated steam locomotive were used, and both were accurately logged as to the service they performed on the "Hillside Job" at the Holban Yard, where freight cars received from various branches are switched out and trains made up to go to the floats at Long Island City to transfer to other railroads. Cars were also taken to industrial sidings in the vicinity.

The oil-electric locomotive was used from 4 P. M., February 3, to 12 midnight, February 5, a period of 56 hours. The same kind of work was done by the steam locomotive from 7 A. M., April 20, to 5 A. M., April 23, a period of 70 hours. Ten hours of this time were consumed, however, in reconditioning the engine and returning it from Holban Yard to Morris Park.

The oil-electric locomotive had a 40-min. delay because of a hot generator bearing resulting from a clogged oil pipe. Aside from this, the engines gave similar performance and satisfactory results. The time to replenish the fuel and water supply of the oil-electric unit was longer than it would have been if the locomotive had been in regular service and the railroad properly equipped for the type.

The summaries of the tests, which were made under the direction of G. C. Bishop, superintendent of power of the Long Island Railroad, and included in the following tables, show the striking economic advantages of the oil-electric locomotive.

RECORD OF TESTS

	Oil-Electric	Steam
Fuel Used.....	224 gals. oil (Approx. 1,650 lbs.)	38,070 lbs. coal 19.03 tons
Water used.....	360 gals. (47.88 cu. ft.)	28,245 gals. (3,756.59 cu. ft.)
Miles run.....	142	
Kwh. generated.....	1,950	
Lubricating oil used.....	30 gals. Diesel engine oil, 1 pt. engine oil	2.5 pts. valve oil, 4 pts. eng. oil
Cars switched.....	1,047	1,321
Cuts made.....	562	604
Trains pushed.....	2	1
No. cars in train.....	77	30
Total cars handled.....	1,124	1,351
Total hours on test.....	56	70
Time out of service on account of engine fail- ures	40 minutes*	
Time required for re- fueling, cleaning fires, taking water, lunch, etc.	7 hours	10 hours
Actual working time....	48 hrs. 20 min.	60 hours
Total cars handled di- vided by total hours on test equals average cars handled per hour.....	20.07	19.30
Total cars handled di- vided by actual work- ing time equals aver- age cars handled per working hour	23.27	22.51
Cars switched divided by number cuts made equals number of cars per cut.....	1.8	2.1

*Thirty minutes is usually required to refuel for 48 hours' service, but there was an excessive delay caused by dirty oil, put there by an inexperienced man, blocking the fuel system.

COMPARISON OF TESTS

	Oil-Electric	Steam
Fuel, 224 gals. oil at \$.05½.....	\$12.32	
19.03 otns coal at \$.5384.....		\$102.46
Water, 48 cu. ft. at .08 per 100.....	.038	
3,757 cu. ft. at .08 per 100.....		3.016
Diesel lub. oil, 30 gals. at .60.....	18.00	
Engine oil, 1 pt. at .14¾.....	.148	
4 pts. at .14¾.....		.59
Valve oil, 2½ pts. at .25¾.....		.644
Total costs.....	\$30.506	\$106.710

The wages of crews are not included since they are constant, although with the oil-electric locomotive only an engineer is necessary where the law of safety does not require a second man for lookout.

The charge of \$18.00 for lubricating oil for the oil-electric locomotive is high since the oil is changed periodically and represents more than that actually consumed in the 56 hours of operation. The guaranteed operation is three hours engine operation per gallon of lubricating oil. On this basis the cost of lubricating oil would have been \$11.16.

SPECIFIC COSTS

	Oil-Electric	Steam
Cost per hour on test		
\$ 30.51 divided by 56.....	\$.544	
106.71 divided by 70.....		\$ 1.524
Cost per actual working hour		
\$ 30.51 divided by 48.3.....	.631	
106.71 divided by 60.....		1.778
Cost per car handled		
\$ 30.51 divided by 1,124.....	.027	
106.71 divided by 1,351.....		.078
Cost per 24-hour day		
\$.544 times 24.....	13.056	
1.524 times 24.....		36.576

Central New Jersey Tests.

In the case of the Central Railroad of New Jersey, which has obtained a 60-ton oil-electric locomotive, operating figures show that the locomotive handled and distributed 431 cars, moving them on and off 26 car floats, in the course of six days' operation. The work was done in 61 hours and 50 minutes, in which time the locomotive consumed fuel. A steam locomotive in the same service handled 430 cars, on and off 26 floats, doing the work in 75 fuel-consuming hours. The steam locomotive also stood by, with its fires banked for 69 additional hours, ready for service. During this time the total fuel and lubricating cost of the steam locomotive was \$73.35, and that of the oil-electric was \$11.90.

Engineers estimate that the general use of oil-electric locomotives would reduce the fuel bill of the railroads from \$500,000,000 to \$125,000,000.

Industrial Possibilities of the Oil-Electric Locomotive.

This type of locomotive has been discussed above in its applications to steam railroad service, but the results indicate the possible application and advantages of the same type of locomotive in industrial yards.

Industrial plants are not generally equipped with shops and facilities for the convenient and economical repair of locomotives. As a consequence, the maintenance of steam locomotives is higher than would be the cost of the same locomotive on steam railroads. The parts of the oil-electric locomotive are small, convenient of access and, as a consequence, the maintenance of such a locomotive, as compared with a

steam locomotive, would be even more economical in an industrial plant than on the ordinary steam road.

In industrial plants the switching service is frequently intermittent, even more so than in large steam railway terminals. In all cases of intermittent service, it is a fact that the steam locomotive is using fuel during all the period when the steam pressure is kept up. On the other hand, the oil-engined locomotive uses fuel only during the period when it is exerting power, and only in proportion to the power used. As a consequence, the more intermittent the service, the greater is the advantage of using an internal combustion type of engine in the power plant.

The tracks of industrial yards are not generally maintained in as good repair and alignment as those in steam yards. The swivel-truck type construction of the oil-electric locomotive gives it a flexibility, when compared with the rigid wheel base of the steam locomotive, which makes it more suitable for such uneven types of track, gives it better traction possibilities and tends to reduce the maintenance of both the locomotive and the track.

In such points as indicated above, there is an even greater advantage in the use of the oil-engined locomotive in industrial yards than in steam terminals, and there is no question but that a wide opportunity is presented in industrial service for this type of locomotive.

Gas Making from Western Coals

In co-operation with the Pacific Coast Gas Research Council, a study is being made by the Bureau of Mines of the feasibility of utilizing coals available on the west coast for the manufacture of city gas. Laboratory studies of the gas producing qualities of various western coals, operating tests in gas plants, and the economic possibility of using them for the manufacture of city gas will be investigated.

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The Safety Calendar

Nine Thousand Youthful Competitors Were Sworn in Under the Crusader's Banners, Each Contributing Poster Designs

By JOHN A. OARTEL*

A CALENDAR for 1926 put out by the Carnegie Steel Company of Pittsburgh is a most striking exemplification of a spirit that may well be emulated by industry in general, not necessarily along this direct line of thought but through one of the many other avenues of employer and employee relations. While the calendar is built around safety and the propagation of the safety idea, its results are more far

reaching than would appear at first contemplation. This is the third year the calendar idea has been carried out by this company and the present one is said to far eclipse the former productions.

There are twelve pages to the publication, one each carrying the calendar pad for each month, and a front page bearing a half tone of the new bronze safety trophy which will be put into competition in the safety work among the half score plants of the company.

*Director of Safety, Carnegie Steel Co., Pittsburgh, Pa.



Such suggestions as this keeps Safety firmly fixed in mind.

Each page of the monthly sheets of the calendar is embellished with an accurate reproduction of a safety poster done by some school child. To obtain these posters, a safety poster contest was held in the public and parochial schools in each town or city where there is a Carnegie Steel mill or plant. Each community had its own school contest, with separate judges and separate prizes. The prize winners were then sent to the General Offices in Pittsburgh where the General Safety Committee selected the posters to make up the calendar.

There were approximately 9,000 posters submitted in the contests this year, and the character of the work of the school children showed a marked advance in excellence over the preceding years. In selecting the posters for the calendar, the General Safety Committee did not confine itself necessarily to first prize winners, but rather made the selection that would add to the general ensemble. It was the desire that every plant community should be represented, and also that each sheet should represent a different thought or idea of safety. This has been admirably accomplished, and the spirit of fairness displayed is to be commended.

The Safety Poster idea is growing in popularity and the standard of work turned out by school children is such that it is engaging the pedagogical thought and minds. In one plant community the poster contest resulted in the installation of an art instructor in the public schools which never had one before. The poster idea is educating boys and girls to safety that will make them better and safer workmen and housewives as they grow to maturity, and at the same time it is carrying safety home to the parents who heretofore had but a passing interest in this humanitarian work.

All in all the effort of the Carnegie Steel Company is one that, judged from past results, and the future prospects, is well worth while. Its cost is more than justified. It perhaps does not sell any steel, but it does "sell the company" to its employees and to the future citizens and workmen in its plant communities. It does bring home to families and children that a corporation has a heart, and that it has an interest in its workmen and its families, and it does inculcate in the young folk a love of color, of line, and incidentally of the finer things of life—an air of refinement.

The aptitude of the children may be contemplated when it is considered that the posters are exact reproductions as to color, line, thought and idea. In no way has the printer or the printer's artist changed them, except in some instances in reducing them in size to make the calendar uniform.

The bronze safety trophy portrayed on the front of the calendar is the fifth that the Carnegie Steel Company has presented for competition. It is held each month by that plant making the greatest percentage in reduction of lost time accidents over the corresponding month for the previous five years, and at the end of the year, on the same basis for the year, the trophy is awarded perpetual ownership to that plant that wins.

This trophy is somewhat larger than the four preceding ones, standing over 5 ft. high. It was designed and executed by Mr. G. Moretti of Florence, Italy, who for some years was a resident of Pittsburgh. As with others, there is a story of the composition—a theme about which it is built. In this instance the

theme is that of the dream ship "Destiny", suggested by the familiar phrase of "Our Ship Coming In." A large ancient galley ship is chosen both for its beauty and because the galley was moved by direct human effort. A tall, beautiful youth stands on deck holding a rudder bearing the words, "Safety First." In the right hand he holds aloft a light, signifying youth as the Light Bearing Ideal. In the shallow water on either side are two splendid running figures. They are Labor and Industry bringing the ship to landing. The ship is the Spirit of Destiny. It has great sweeping wings on either side, for the spirit moves in earth, air, and water and penetrates the mind of man of every position, in every place, and under all circumstances.

Gas Engine Tests

The object of the investigation leading to the publication of Bulletin No. 150 of the Engineering Experiment Station of the University of Illinois, entitled "A Thermodynamic Analysis of Gas Engine Tests," was to apply to rational thermodynamic analysis of the constant volume, or Otto, cycle to test results obtained from an engine operating on such a cycle, and from a comparison of results from theory and experiment to discuss the factors which prevent the actual engine from attaining the ideal performance as defined by the thermodynamic analysis. Furthermore, by a combination of laboratory data and thermodynamic theory it was possible to throw considerable light on such processes as the rate of reaction in the cylinder of the engine, and the magnitude of the heat losses during different parts of the cycle. Copies of Bulletin No. 150 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Ill.

Republic Level Recorder

A 4-page circular describing the new Republic Electrical Level and Pressure Indicator and Recorder has recently been distributed.

The instrument described and pictured is no departure from an application of the principle used in the Standard Republic Flow Meter. In the past, many similar applications have been made, but only recently has this instrument been added as a standard feature in the line.

The folder illustrates the construction and indicates a few of the many applications.

Homestead's New Bloomer Starts

The Carnegie Steel Company, Pittsburgh, Pa., is making rapid progress on the construction of the new structural mill at its Homestead, Pa., works, at which an expansion program is in progress, to be used primarily for the rolling of H-beam sections. The new mill unit will consist of a 54-in. blooming mill, and three 52-in. mills, with a rougher, intermediate and finishing unit. All of the new equipment will be electrically-operated. The blooming mill is said to be the largest unit of such type ever built up to the present time and will weigh close to 3,000 tons. Work now under way includes a new 28-32-in. mill, electrically operated, and which is expected to be ready for service before the close of the year.

NEWS OF THE PLANTS

The Inland Steel Company, Chicago, Ill., is pushing construction on the expansion program at its Indiana Harbor, Ind. plant, in course of work for a number of months past, and plans to have different sections ready for service in the near future. A new blast furnace is well under way at Plant No. 2, designed as one of the largest stacks in the world, and the unit will be ready for blowing in early in 1926. This stack will represent an investment of close to \$1,000,000. The new No. 6 ore bridge at the unloading wharves, near the new blast furnace, has now been completed and is available for operation. Plant No. 1, is being electrified in all departments, and this branch of the mill expansion has also made excellent progress. At the coke works, a battery of 75 additional by-products coke ovens is in course of installation, as well as a new by-products plant for tar and affiliated products manufacture. The entire program is estimated to cost close to \$6,500,000 including buildings and machinery.

The Huronia Steel Company, Ltd., Collingwood, Ont., recently formed with a capital of 50,000 shares of stock, no par value, has concluded negotiations for the local plants previously operated by the Kennedy Company and the Electro Castings Company, and will remodel and expand for a new steel mill. Plans are under way for the installation of a large amount of new equipment for the production of rolled products, including bars for concrete reinforcement, steel shapes, etc. The new equipment will include rolling mills and accessory apparatus, an electric furnace and power equipment. It is expected to provide facilities for the employment of more than 250 men.

The Republic Iron & Steel Company, Youngstown, Ohio, has preliminary plans under way for extensions and improvements in its mill at Birmingham, Ala. The work as now tentatively arranged, will include the construction of additional open hearth furnaces, rolling mills and other plant units, with the installation of considerable new equipment for large increase in present production. The expansion is reported to cost in excess of \$1,500,000, including machinery.

The Ford Motor Company, Highland Park, Detroit, Mich., is making substantial progress in the construction of its new steel mill at the River Rouge plant, and initial units, comprising blooming and bar mills, have now been placed in service. This section of the plant is completely electrified, and has a rated output of 20,000 tons of material per month. Work is under way on the open-hearth furnaces, and it is expected to have this division of the works ready for operation early in the spring, when full capacity will be developed.

The Tennessee Coal, Iron & Railroad Company, Birmingham, Ala., has completed three units of the new sheet mill at its Fairfield, Ala., works, in course

of building for a number of months past, and will inaugurate operations immediately. The hot mills each have a rated output of 3,000 tons of material per month and will be developed to maximum at once. The company is said to have booked heavy orders for the new sheet production at the plant and will operate the units indefinitely. Extensive additions have been made in the working forces.

The Buckeye Steel & Tube Works, Inc., Sandusky, Ohio, recently organized, has taken over the former local plant of the Dauch Manufacturing Company, manufacturer of motor tractors, and will remodel and convert the property for steel tube and kindred production. A large addition will be constructed to the present buildings, utilizing a tract of land adjoining the plant. It is purposed to develop the plant into five complete operating units, with cost estimated at close to \$250,000, with machinery. A list of equipment to be installed is being arranged. H. E. Latshaw is president of the new company, and H. A. Relberi is treasurer.

The Pittsburgh Tin Plate & Steel Corporation, Marietta, Ohio, recently reorganized, has recently resumed production in all departments of the plant, following a shut-down for some months past. The four hot mills and other divisions will be placed on a full turn and maximum output developed. A number of improvements have been carried out at the plant, including the electrification of the rolling mills, replacing steam-power apparatus. A. V. Somers is general manager.

The Union Drawn Steel Company, Hartford, Conn., has plans for the construction of a new addition to its plant on Capitol Avenue, comprising a one-story unit, 60 x 255 ft., estimated to cost in excess of \$65,000. Considerable additional equipment will be installed.

The Penn-Seaboard Steel Corporation, Philadelphia, Pa., is placing orders for equipment for its New Castle, Del., works, in connection with extensions and improvements at the mill. Arrangements have been made for the installation of a new 16-in. bar mill, designed to produce material from 2-in. to 6¾-in. The new unit will have a capacity varying from 300 to 600 tons in a 24-hour period, depending upon the size of bar produced. It will be electrically-operated. The company is said to be planning to contract for other necessary equipment for the expansion program at an early date.

The Dreier Iron Works, Inc., 228 East Fifty-ninth Street, New York, N. Y., operating a structural steel fabricating plant, has acquired an entire block of property at East Twelfth Street and Avenue D, 206 x 269 ft., and is considering tentative plans for the erection of a new works at this location, expected to cost more than \$80,000, with machinery.



H. D. Westfall, who resigned as general sales agent of the Wheeling Steel Corporation, it is understood is to form a connection with the Weirton Steel Company, of Weirton, W. Va. Mr. Westfall, in his new capacity, will be associated with former president R. C. Kirk of the LaBelle Iron Works, who is now connected with the Weirton Company. Mr. Westfall, before the recent consolidation of the Wheeling Steel Corporation was the general sales agent of the LaBelle Iron Works at Steubenville.

John T. Harrington, president-elect of the Trumbull Steel Company, Warren, Ohio, succeeding Philip Wick, of Youngstown, has been identified for many years with the iron and steel industry of the Mahoning Valley in an advisory capacity. He served as temporary president for three months, during the company's financial reorganization, and is one of the largest holders of common stock. Mr. Harrington has assumed his new duties and will devote all of his time to the Trumbull Company, retaining residence in Youngstown.

Newlin T. Booth, president Deemer Steel Casting Company, New Castle, Del., has been elected president of the Delaware Safety Council, succeeding C. H. Quackenbush, resigned. Before coming to Delaware, Mr. Booth was superintendent of one of the Bethlehem Steel Company plants.

Bethlehem Steel Company expects to start operating its new 28-in. structural mill at Buffalo during the last half of December. It expects also to begin operations on its new 14-in. structural mill at Buffalo in February, 1926.

The Huronia Steel Company, Ltd., has purchased the building and plant of the Kennedy Company and the Electro Castings Company, both of Collingwood, Ont. The company will equip the plant for the production of high grade steel from electric furnaces by the triplex process.

F. C. Holzworth, superintendent of blast furnace for Sharon Steel Hoop Company, Sharon, Pa., has resigned. He will operate the Struthers Furnace on a lease or under contract it is reported. Receiver H. W. Grant was granted permission to operate the stack and to engage Mr. Holzworth to operate it.

William J. Weir, new superintendent of the steel foundries of the Locomotive Finished Material Company, Atcheson, Kans., formerly was superintendent of the Springfield, Ohio, plant of the Ohio Steel Foundry Company.

Since the first of the year, under the direct supervision of Dr. Fahrenwald, American Manganese Steel Company have been making and applying these alloys to various types of castings. The results obtained for the users by the combination of a careful investigation of a particular problem, with proper design, and the fully proved heat and corrosion-resisting qualities of these alloys, have been gratifying indeed. Astounding as some of the comparisons are, between the length of service given by "Fahralloy" and that obtained from ordinary metals, they are facts, and new instances are occurring frequently.

Effective December 14, 1925, the general offices of the Penn Seaboard Steel Corporation and the Tacony Steel Company will be located at New Castle, Del. The president's office and Philadelphia district sales office will be located at the present address, Franklin National Bank Bldg., 1417 Sansom Street, Philadelphia. On and after the above date, all mail should be addressed to the corporations at New Castle, Del., with the exception of mail intended for the president, which should be addressed to the Philadelphia office.

The February issue of The Blast Furnace and Steel Plant will contain Annual Reviews covering Power, Open Hearth, Electric Furnaces, Electro-Chemistry, the Architectural and Building Forecast, together with an analysis of Foreign Conditions by British Correspondent.

BY-PRODUCT AND CHEMICAL NEWS

By-Product Coking of Illinois Coal

Has Important Bearing Upon Industrial St. Louis

MEMBERS of the New Industries Committee of the Illinois Chamber of Commerce, with headquarters in Chicago, held a day's conference recently in Granite City at which the availability of the city with special reference to its coke and pig iron industry was discussed after the visitors had made an exhaustive study of processes as employed at the plant of the Midland Coke & Iron Corporation, formerly the St. Louis Coke & Iron Company. The purpose of the conference was to acquaint this important committee of the Illinois Chamber of Commerce with what Granite City has to offer to those who would build factories to use the many by-products of the coke industry.

The conference was the first held by the New Industries Committee and was regarded as highly important for the Illinois industrial region centering around Granite City in that representatives of more than 30 Illinois cities were in attendance and the committee itself was comprised of men of importance in the commercial world. Scott Brown, vice president of the Illinois Power & Light Corporation, Chicago, is chairman of the committee and presided at the noon luncheon where the most extensive discussions took place.

Inasmuch as the conference was chiefly concerned with the operations of the Midland Coke & Iron Corporation, officers of that concern were the main speakers at the luncheon, including William G. Maguire of St. Louis, president; M. D. Curran of St. Louis, vice president, and Leonard Busby of Chicago, chairman of the board.

Curran was the first speaker and briefly related how his company has utilized the coal products of the nearby Illinois fields, stating that the transportation demands of the plant ordinarily demand the use of four locomotives in handling inbound and outbound material. Track equipment is such, he said, that from 200 to 300 cars of freight may be handled each day, and that with the completion of additions now being made, the annual freight movement will run in excess of 2,000,000 tons. He asserted that the qualities of coke made from Illinois coal are quite remarkable when compared with that made from the standard grades or coking coal and declared that for use in the manufacture of pig iron it is beyond doubt a higher grade fuel than is obtained from the so-called high-grade coals.

Maguire, who was president of the concern when it was the St. Louis Coke & Iron Company and who is president of the reorganized corporation, explained the difficulties that have been encountered which led to eventual receivership. The company was started, he said, at a time when all building material was purchased at peak war prices, the direct consequence

being that original cost estimates were found to be entirely too low and the completed plant represented an expenditure far beyond the first building program.

"The St. Louis district has all the elements necessary for the cheap production of steel," said Maguire. "It has coke, iron ore, an adequate market and transportation. Using Northern ore, we can produce a ton of pig iron at \$1.50 less than they do at Gary, and if we use Missouri ore we can do it for \$3.50 a ton cheaper. Compared with Pittsburgh, we have an \$8.50 advantage in assembly charges for materials on every ton of pig iron produced.

"Ninety miles from Granite City, in Missouri, we have a definite supply of iron ore. Besides that we have in St. Louis the cheapest scrap iron market in the country. Thus far our plant has utilized between 2,000,000 and 3,000,000 tons of Illinois coal in its coking operations."

Clarence Howard, president of the Commonwealth Steel Company, was enthusiastic in his prediction that the St. Louis district, a newcomer in the steel industry field, will in time eclipse both Pittsburgh and Gary, asserting that he saw "steel mills literally covering all the land between here and Belleville, 30 miles to the south."

"St. Louis is the biggest open hearth steel market in the world," he said. "Furthermore all the steel for the southwestern part of the country passes through St. Louis."

He alluded to the fact that the Commonwealth Steel Company had its period of adversity similar to that encountered by the St. Louis Coke & Iron Company, but to indicate the possibilities that lie in this field said that his concern now has an annual payroll of \$5,000,000.

Progress at Jones & Laughlin

The Jones & Laughlin Steel Corporation, Pittsburgh, Pa., has perfected plans for an addition to coke plant in the Hazelwood district, to consist of a fifth battery of 60 ovens and auxiliary equipment. The other batteries, totaling 240 ovens, have been in active service for some time past, and the final unit, as now provided, will bring the plant to the capacity originally intended. The new battery will be installed by the Wilputte Coke Oven Corporation. The company has work in progress on a similar project at its Aliquippa Works, Woodlawn, Pa., consisting of 122 new ovens of Becker type, bringing the entire quota of 422 ovens at the plant, with a rated output of close to 2,000,000 net tons of coke per annum. This last noted installation is being carried out under the direction of the Koppers Company.

WITH THE EQUIPMENT MANUFACTURERS

Steam Generating Unit Simplifies Present Methods of Steam Production

The Combustion Steam Generator represents the most radical and important development that has thus far occurred in steam boiler practice. Generally speaking, there has been no substantial improvement in boiler design in many years. The present type of boiler, with minor exceptions, has not advanced since the days of James Watt. It has never been considered in rational designs either as a steam generator or as a part in the complete unit, comprising fuel burning equipment, superheater and air heater. In other words, for possibly 150 years the generation of steam through boilers has not advanced in keeping with the Combustion process. Engineers have known that the lower row of tubes in a boiler exposed to the radiant heat of the fire and the heating surface included in the first pass, do a very large percentage of the total work, but they have found no way to apply this basic fact to the present-day type of boiler.

It is the application of this principle that has been responsible for the remarkable results obtained with the Combustion Steam Generator. In this generator practically all the boiler heating surface is exposed to radiant heat. The application of pulverized fuel firing to the generator design permits the elimination of the large furnace with its refractory surfaces, water screens, side wall screens, etc., required with all existing types of boilers.

The Steam Generator unit consists of a furnace, the walls of which are composed of tubes of the fin type, all exposed to radiant heat. Pulverized fuel is introduced through burners in the four corners and burned in a turbulent condition in the form of a vortex, due to the fact that the primary mixture of fuel and air as well as the highly preheated secondary air enter tangentially to an imaginary circle.

The flame and gases descend through a multi-tubular water screen into a settling chamber where the ash is deposited and the gases flow through a superheater, thence through an air preheater to the stack or to the induced draft unit.

In the Combustion Steam Generator a definite dependable circulation is established. Water fed to the main drum descends through the outside circulating tubes to the lowermost drum; from this drum it passes through the vertical fin tubes forming one wall of the combustion chamber to the lower of the upper drums, from there through the connecting tubes forming the roof of the furnace into the main drum. The lowermost drum also supplies water to the bottom water-screen and the other connecting drum from which it passes through the vertical fine tubes into the main drum.

The horizontal headers for the remaining two side walls are, as mentioned before, also connected to the lowermost drum, receiving their water supply from this drum and discharging into the upper headers which in turn are connected to the main drum.

As will be evident, probably the greatest saving due to the new Steam Generator will be in the construction cost of the plant. This unit which can be installed in from one-half to two-thirds the space required for present-day boiler units to produce the same amount of steam, means a great saving in labor construction cost and real estate investment. It is estimated that on a station costing \$50,000,000 that the Combustion Steam Generator units would effect a saving between \$10,000,000 and \$15,000,000 over present design and construction costs. Another element which is worthy of consideration is the reduction of time necessary to build and equip a power plant against present-day methods. This unit introduces a new era in power plant practice.

The development of the Combustion Steam Generator unit establishes pulverized fuel as the most economical method of burning coal, because the new unit reduces the investment charges which, in the past few years, have been growing steadily until the margin of benefits over simpler types of fuel burning methods have in many cases been questioned. By removing all the auxiliary equipment and designs necessary to burn pulverized fuel most efficiently, the Steam Generating unit has brought into one a pulverized fuel unit, a completely enclosed water cooled furnace and the advantages of highly preheated air. The Combustion Steam Generating unit is the logical outgrowth of these developments which have covered a period of about 10 years.

General Electric Catalogue

General Electric Catalogue 6001-B, superseding all previous catalogues issued by the company, with the exception of those dealing with railway, mine and industrial supplies and merchandise products, is being distributed. The complete catalogue is issued every two years.

The book is two inches thick, and contains more than 1,100 8x10½-inch pages. The illustrations total more than 3,200. The catalogue is thumb-indexed into 16 sections as follows: Generation, wire and cable, distribution transformers, arresters, voltage regulators, switchboards and accessories, meters and instruments, motors, motor applications, industrial control, railway lighting, industrial heating, miscellaneous, and indexes. In the indexes, products are classified both by subjects and by catalogue numbers.

Revolving Distributors

Arthur G. McKee & Company, engineers and contractors, Cleveland, have received orders from the Carnegie Steel Company for McKee revolving distributors to be installed on Carrie Blast Furnaces Nos. 1 and 2 of their Homestead Works. McKee & Company will also furnish three double hopper larry cars, each of 300 cubic feet capacity, for use with the Carrie furnace storage bin system which is being reconstructed and provided with Baker type bin bottoms.

The Blast Furnace *(and)* Steel Plant

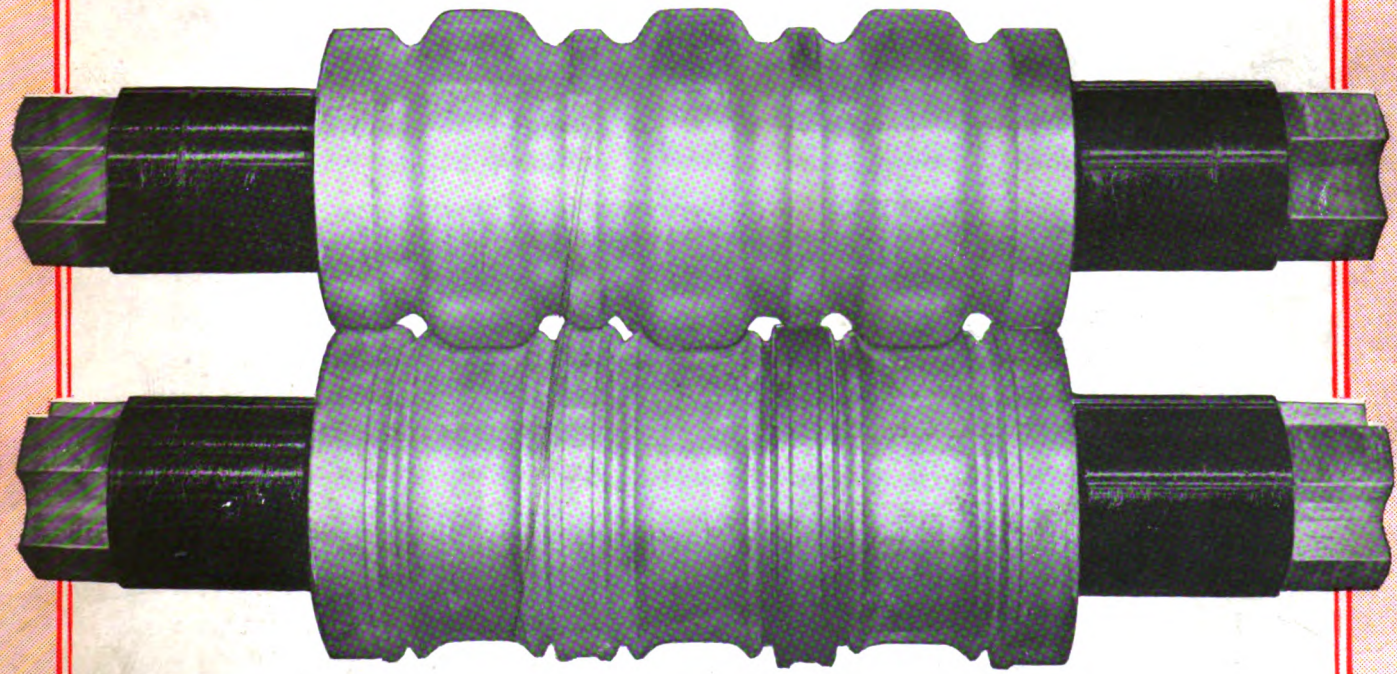
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